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# 213 DMM OSCILLOSCOPE

WITH OPTIONS

SERVICE

INSTRUCTION MANUAL

**Tektronix, Inc.**
**P.O. Box 500**
**Beaverton, Oregon 97077**

070-1481-00
Product Group 40

Serial Number _____

First Printing JAN 1975
Revised JUL 1989

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| | |
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| B000000 | Tektronix, Inc., Beaverton, Oregon, U.S.A. |
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| E200000 | Tektronix United Kingdom, Ltd., Marlow |
| J300000 | Sony/Tektronix, Japan |
| H700000 | Tektronix Holland, NV, Heerenveen, The Netherlands |

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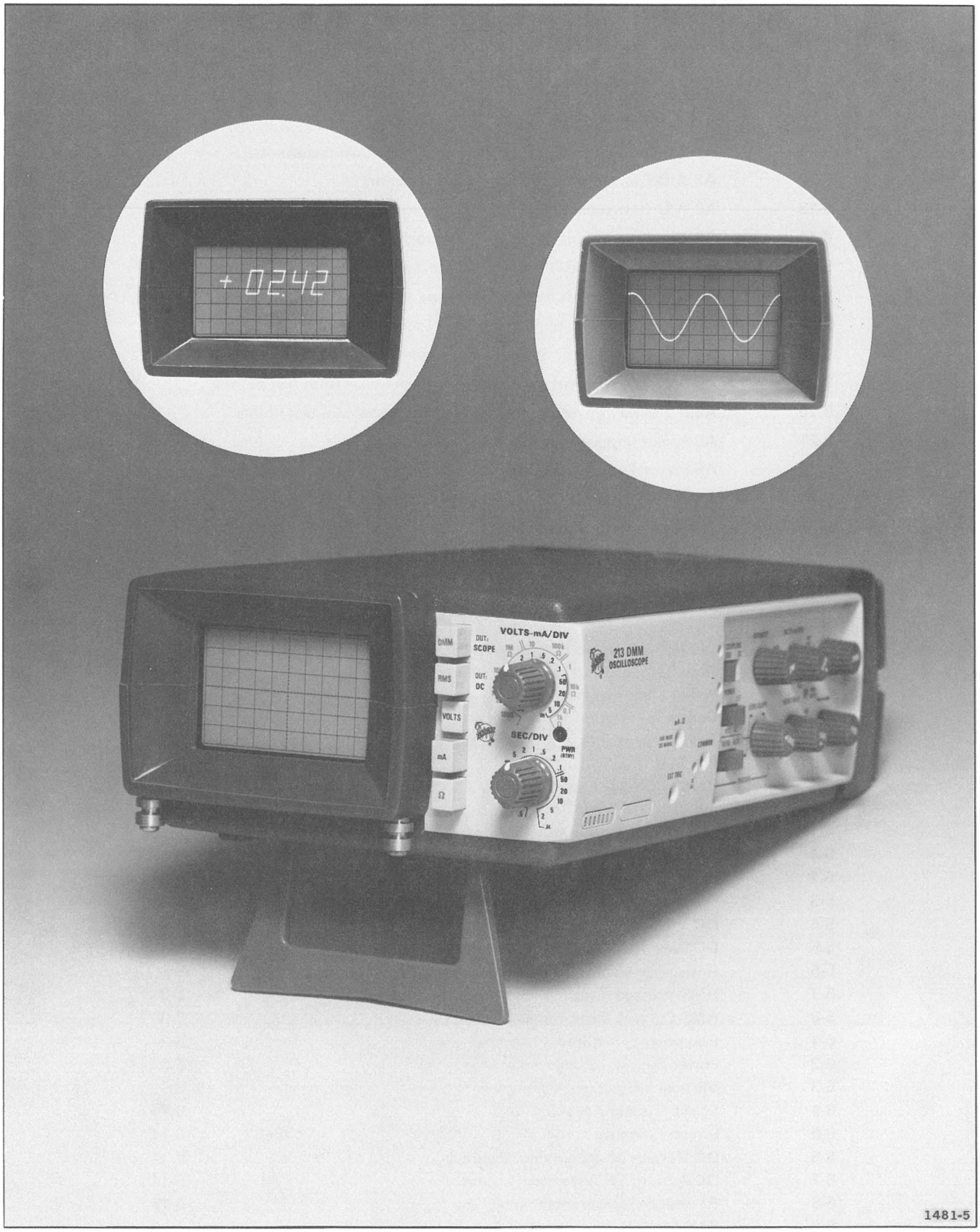
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213 DMM Oscilloscope

# SPECIFICATIONS

The 213 DMM Oscilloscope is a portable measurement instrument that is designed to be used as either a digital multimeter or an oscilloscope. Function selection is made with a front-panel pushbutton switch. Voltage measurements are made with the integral high-impedance probe, while current and resistance measurements are made through a low-impedance banana jack input on the side panel. Operating power is provided by internal rechargeable batteries or from power-line voltage. An integral battery charger recharges the batteries whenever the instrument is connected to the power line.

The digital multimeter measures ac or dc voltage and current, and resistance. It features true rms responding circuitry when making ac voltage or current measurements. Full scale measurement ranges are 0.1 to 1000 V, 0.1 to 1000 mA, and 1 kΩ to 10 MΩ with a 200% full scale overrange on all ranges except 1000 V. The crt readout is a 3½-digit display containing an automatic polarity indicator, and a decimal point which is positioned by the range selector switch. Overrange is indicated by an unblanked readout display consisting of scrambled character segments.

The oscilloscope function provides a single channel, dc to 1 MHz vertical deflection system with calibrated deflection factors of 5 mV to 100 V/division with a reduced bandwidth of dc to 400 kHz on the 5 mV and 10 mV ranges. Current deflection factors are 5 μA to 100 mA/division from dc to 400 kHz with a reduced bandwidth of dc to 200 kHz on the 5 μA and 10 μA/division ranges. The horizontal deflection system provides calibrated sweep rates from 0.5 s to 2 μs/division, with a variable sweep magnifier that provides uncalibrated sweep rates to at least 5 times faster than the selected rate. The trigger input is either internal or external and provides stable triggering over the full bandwidth of the vertical deflection system. The oscilloscope crt display is a 6 x 10 division graticule with each division approximately 0.2 inches (0.5 cm).

The following instrument specifications apply over an ambient temperature range of −15°C to +55°C unless otherwise specified. Warm up time for specified accuracies is 10 minutes. If the instrument is already stabilized at the ambient temperature, warm up time is 10 seconds.

TABLE 1-1
**Digital Multimeter Electrical Specifications**

| Characteristic | Performance Requirement |
|---|---|
| DC AND RMS VOLTS | |
| Range | 0.1 V to 1000 V |
| Resolution | 100 μV at 0.1 V full scale (reading must be at least 10% of full scale) |
| Input Resistance | 10 MΩ within 1% |
| Input Capacitance | |
| 0.1 V to 10 V | Approximately 150 pF |
| 100 V to 1000 V | Approximately 100 pF |
| Input Leakage Current | 200 pA max at 30°C or less with 2 mV or less change from open to shorted probe |

TABLE 1-1 (continued)
Digital Multimeter Electrical Specifications

| Characteristic | Performance Requirement |
|---|---|
| Max Safe Input Voltage | Ac component 1 MHz or less |
| 0.1 V to 10 V | |
| Dc Coupled | 500 V (dc + peak ac). |
| Ac Coupled | 800 V (dc + peak ac). Max ac component is 500 V peak |
| 100 V and 1000 V | 800 V (dc + peak ac) |
| DC VOLTS | |
| Accuracy (+20°C to +30°C, batteries only) | **NOTE** *When operating on power-line voltage, add 10°C to the ambient temperature for internal heating before computing accuracy* |
| 0.1 V | Within 0.1% of reading ±3 counts. Temp Coef is (within 0.015% of reading + 0.04% of full scale) per °C |
| 1 V | Within 0.1% of reading ±1 count. Temp coef is (within 0.01% of reading + 0.01% of full scale) per °C |
| 10 V and 100 V | Within 0.15% of reading ±1 count. Temp Coef is (within 0.015% of reading + 0.01% of full scale) per °C |
| 1000 V | Within 0.2% of reading ±1 count. Temp Coef is (within 0.02% of reading + 0.01% of full scale) per °C |
| Settling Time | 1.5 seconds for reading within 0.1% |
| Normal Mode Rejection Ratio | –60 dB at 60 Hz, –3 dB at 1 Hz |
| RMS VOLTS | Temp Coef is (within 0.05% of reading + 0.1% of full scale) per °C |
| Accuracy (+20°C to +30°C, batteries only) | **NOTE** *When operating on power-line voltage, add 10°C to the ambient temperature for internal heating before computing accuracy* |
| **NOTE** *Crest factor < 2 and reading at least 10% of full scale. Accuracy limits increase linearly for crest factor over 2; up to twice indicated limits for crest factor of 5* | Within % of reading shown ±5 counts at frequency shown: |

| | Dc | 40 Hz to 1 kHz | 1 kHz to 40 kHz |
|---|---|---|---|
| 0.1 V | 2.5% | 1.5% | 3.5% |
| 1 V | 2% | 1% | 1% |
| 10 V | 2% | 1% | 5% |
| 100 V | 2% | 1% | 1% |
| 1000 V | 2% | 1% | 5% |

TABLE 1-1 (continued)
Digital Multimeter Electrical Specifications

| Characteristic | Performance Requirement |
|---|---|
| Settling Time | 2 seconds for reading within 1% |
| Max Crest Factor[1] | Approximately 5 |
| DC AND RMS CURRENT | |
| Range | 0.1 to 1000 mA |
| Resolution | 100 nA at 0.1 mA full scale (reading at least 10% of full scale) |
| Input Shunt Resistance (Approximate) | |
| 0.1 mA | 1000 Ω |
| 1 mA | 100 Ω |
| 10 mA | 10.2 Ω |
| 100 mA | 1.2 Ω |
| 1000 mA | 0.3 Ω |
| Max Safe Input Current | 2 A rms on any scale or 3 A peak |
| DC CURRENT | |
| Accuracy (+20°C to +30°C, batteries only) | Temp Coef is (within 0.02% of reading +0.04% of full scale) per °C<br>**NOTE**<br>*When operating on power-line voltage, add 10°C to the ambient temperature for internal heating before computing accuracy* |
| 0.1 mA Range | Within 0.5% of reading ±3 counts |
| 1 mA to 1000 mA | Within 0.25% of reading ±3 counts |
| Settling Time | 1.5 seconds for reading within 0.1% |
| RMS CURRENT | |
| Accuracy (+20°C to +30°C)<br>**NOTE**<br>*Crest factor < 2 and reading at least 10% of full scale. Accuracy limits increase linearly for crest factor over 2; up to twice indicated limit for crest factor of 5* | Temp Coef is (within 0.05% of reading + 0.1% of the full scale) per °C<br>**NOTE**<br>*When operating on power-line voltage, add 10°C to the ambient temperature for internal heating before computing accuracy* |

[1] **Supplemental information only.**

TABLE 1-1 (continued)
Digital Multimeter Electrical Specifications

| Characteristic | Performance Requirement | | |
|---|---|---|---|
| | Within % of reading shown ±5 counts at frequency shown: | | |
| | Dc | 40 Hz to 4 kHz | 4 kHz to 40 kHz |
| 0.1 mA | 2.5% | 1.5% | 4.5% |
| 1 mA to 1000 mA | 2.5% | 1.5% | 3.5% |
| Max Crest Factor[1] | Approximately 5 | | |
| Settling Time | 2 seconds for reading within 1% | | |
| DC Current Rejection[1] | No provision for blocking dc for rms reading of ac component only | | |
| RESISTANCE | | | |
| Range | 1 kΩ to 10 MΩ | | |
| Resolution | 1 Ω on 1 kΩ range (reading at least 10% of full scale) | | |
| Accuracy (+20°C to +30°C, batteries only) | **NOTE**<br>*When operating on power-line voltage, add 10°C to the ambient temperature for internal heating before computing accuracy.* | | |
| 1 kΩ | Within 0.5% of reading ±3 counts. Temp Coef is (within 0.03% of reading +0.04% of full scale) per °C | | |
| 10 kΩ to 1 MΩ | Within 0.5% of reading ±1 count. Temp Coef is (within 0.02% of reading + 0.02% of full scale) per °C | | |
| 10 MΩ | Within 1% of reading ±1 count. Temp Coef is (within 0.05% of reading + 0.02% of full scale) per °C | | |
| Accidental Voltage Input Protection | 125 V max on all ranges | | |
| Settling Time | 2 seconds for reading within 2 counts | | |
| Reference Current[1] | Approximately 100 μA, 100 μA, 10 μA, 1 μA, and 100 nA for ranges 1 kΩ through 10 MΩ respectively<br>**NOTE**<br>*The potential across the unknown resistance is 1 V per 1000 counts on the 10 kΩ through 10 MΩ ranges and 0.1 V per 1000 counts on the 1 kΩ range. This potential is negative at the mA-Ω jack with reference to common.* | | |

[1] Supplemental information only.

TABLE 1-1 (continued)
Digital Multimeter Electrical Specifications

| Characteristic | Performance Requirement |
|---|---|
| READOUT DISPLAY | |
| Number of Digits | 3½ digits plug decimal and polarity sign |
| Display Size | Approximately 1 cm high and 4 cm wide (5 character display) |
| Sampling Rate[1] | Approximately 7 readings per second |
| Overrange Capability | At least 200% of full scale |
| Indication | Readout displays scrambled character segments or 8's |
| Input Amplifier Overload[1] | Indicates overrange when input signal peak > 4X selected range |
| A/D Converter Overload[1] | Indicates overrange when readout display exceed 2500 within 400 counts |
| RMS Converter Overload[1] | Indicates overrange when crest factor exceeds approximately 5 |

TABLE 1-2
Oscilloscope Electrical Specifications

| Characteristic | Performance Requirement |
|---|---|
| VERTICAL DEFLECTION SYSTEM | |
| Deflection Factor | |
| Calibrated Range | 5 mV to 100 V/div<br>5 μA to 100 mA/div |
| Accuracy | Within 3% |
| Uncalibrated (Variable) Range | Continuously variable between calibrated settings. Extends deflection factor to at least 2.5 times the setting of the VOLTS—mA/DIV control |
| DC Balance[1] | Adjustable to 0.2 div or less trace shift between any deflection factors |
| Variable DC Shift[1] | 0.8 div or less at any setting of the VOLTS—mA/DIV VAR control |
| Position Range (Vertical)[1] | At least 10 div from crt center |

[1] Supplemental information only.

TABLE 1-2 (continued)
Oscilloscope Electrical Specifications

| Characteristic | Performance Requirement |
|---|---|
| **VERTICAL DEFLECTION SYSTEM (cont)** | |
| Frequency Response | |
| 5 μA to 10 μA/div | Dc to at least 200 kHz at –3 dB |
| 20 μA to 200 mA/div | Dc to at least 400 kHz at –3 dB |
| 5 mV to 10 mV/div | |
| 20 mV to 100 V/div | Dc to at least 1 MHz at –3 dB (6 div reference centered vertically) |
| Lower –3 dB point ac coupled (voltage only) | 1 Hz or less |
| Step Response (5 div reference centered vertically; dc coupled)[1] | |
| Risetime | |
| 5 mV and 10 mV/div | 875 ns or less |
| 20 mV to 100 V/div | 350 ns or less |
| Aberrations | +5% to –2%. Total not to exceed 5% p-p |
| Input Resistance (Voltage) | 10 MΩ within 1% |
| Input Shunt Resistance (current) | Approximate: |
| 5 μA to 10 μA/div | 1000 Ω |
| 20 μA to 100 μA/div | 100 Ω |
| 200 μA to 1 mA/div | 10.2 Ω |
| 2 mA to 10 mA/div | 1.2 Ω |
| 20 mA to 100 mA/div | 0.3 Ω |
| Input Capacitance (Voltage) | |
| 5 mV to 1 V/div | Approximately 150 pF |
| 2 V to 100 V/div | Approximately 100 pF |
| Max Safe Input Voltage | Ac component, 1 MHz or less |
| 5 mV to 1 V/div | |
| DC Coupled | 500 V (dc + peak ac) |
| AC Coupled | 800 V (dc + peak ac). Max ac component is 500 V peak. |

[1] Supplemental information only.



@

TABLE 1-2 (continued)
Oscilloscope Electrical Specifications

| Characteristics | Performance Requirement |
|---|---|
| **VERTICAL DEFLECTION SYSTEM (cont)** | |
| 2 V to 100 V/div | 800 V (dc + peak ac) |
| Max Safe Input Current | 2 A rms on any range, 3 A peak |
| DC Current Rejection[1] | No provision for blocking dc current for ac only reading |
| Input Leakage Current[1] | 200 pA maximum at 30°C or less (0.4 div or less trace shift from open to shorted probe) |
| **TRIGGERING** | |
| Trigger Sensitivity | |
| Intl AC Norm | 0.5 div, 7 Hz to 1 MHz |
| Intl AC Auto | Same as Intl AC Norm except the sweep free-runs and provides a bright reference trace when the vertical input signal is not sufficient to cause triggering |
| Ext DC | 1 V, dc to 1 MHz |
| Trigger Jitter | 0.5 μs or less at 1 MHz |
| External Trigger | |
| Input Resistance | 1 MΩ ± 10% |
| Input Capacitance | Approximately 20 pF |
| Maximum Usable Input Voltage[1] | ± 8 volts peak at 1 MHz or less |
| Maximum Safe Input Voltage[1] | 200 V (dc + peak ac) |
| **HORIZONTAL DEFLECTION SYSTEM** | |
| Sweep Rate | |
| Calibrated Range | 500 ms to 2 μs/div |
| Accuracy Over Center 8 Div | Within 5% |
| Linearity of Any 2 Div Portion Within Center 8 Div | Within 5% (magnified and unmagnified) |
| Variable Magnifier Range | Continuously variable between calibrated settings. Extends fastest sweep rate to at least 0.4 μs/div. Each sweep rate magnified by at least 5:1 |
| Horizontal Position Range[1] | Start of sweep can be positioned to the right of center; end of sweep can be positioned to the left of center. |

[1] Supplemental information only.

TABLE 1-2 (continued)
Oscilloscope Electrical Specifications

| Characteristic | Performance Requirement |
|---|---|
| **VISUAL DISPLAY** | |
| Graticule | |
| Type | Internal black line, non-illuminated |
| Area | 6 x 10 div. Each div equals approximately 0.2 inch (0.5 cm) |
| Phosphor | P43 standard |
| Trace Rotation Range[1] | Adequate to align trace with center horizontal graticule line |

TABLE 1-3
Power Requirements

| Characteristic | Performance Requirement |
|---|---|
| **BATTERY OPERATION** | |
| Batteries[1] | Two rechargeable nickel-cadmium D cells |
| Typical Operating Time at Maximum Display Trace Intensity After Full Charge Cycle (Charge and operation at +20°C to +30°C) | 3.5 hours |
| Battery Condition Indicator | LED extinguishes when battery voltage (to common) drops below approximately 2.12 V within 10% |
| Deep Discharge Protection | Instrument operation is automatically interrupted within 4 to 10 minutes after LED extinguishes. (When battery voltage to common drops below approximately 2 V within 0.05 V) |
| Typical Charge Time | 16 hours |
| **POWER LINE OPERATION** | |
| Standard Voltage | 90 V to 136 V, 48 to 62 Hz |
| Option 1 Voltage | 180 to 250 V dc or 180 to 250 V ac, 48 to 62 Hz |
| Max Power Consumption | Less than 8 w |
| Line Fuse[1] | 0.2 A |

[1] Supplemental information only.

TABLE 1-4
Common Isolation Protection

| Characteristic | Performance Requirement |
|---|---|
| Battery Operated (Common Input to Case) | Common input floating voltage not greater than 500 V rms or 700 V (dc + peak ac) |
| Power Line Operated (Common Input to Power Line) | Common input rms floating voltage plus the power line voltage not greater than 250 V rms |
| | Common input composite (dc + peak ac) floating voltage plus 1.4 times the power line voltage not greater than 350 V peak. |

TABLE 1-5
Environmental

| Characteristic | Performance Requirement |
|---|---|
| Temperature | |
| Operating on Batteries | −15°C to +55°C |
| Charging or Operating from Power Line | 0°C to +40°C |
| Storage | −40°C to +60°C |
| Altitude | |
| Operating | To 25,000 feet (maximum operating temperature decreased by 1°C per 1,000 feet above 15,000 feet) |
| Storage | To 40,000 feet |
| Humidity | |
| Operating and Storage | 80% or less relative humidity at 40°C or less |
| Vibration | |
| Operating and Nonoperating | 15 minutes along each of the three major axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one-minute sweeps. Hold for three minutes at 55 Hz. All major resonances must be above 55 Hz. |
| Shock | |
| Operating and Nonoperating | Two shocks at 150 g's, one-half sine, 2 millisecond duration each direction along each major axis. Total of 12 shocks. |
| Transportation (Packaged Instrument) | Qualifies under National Safe Transit Committee test procedure 1A. |

TABLE 1-6
Physical

| Characteristic | Description |
|---|---|
| Dimensions | See Figure 1-1. Dimensional Drawing |
| Weight (Instrument Only) | Approximately 3.7 lb (1.7 kg) |
| Finish | Blue plastic case; gray plastic side panel |

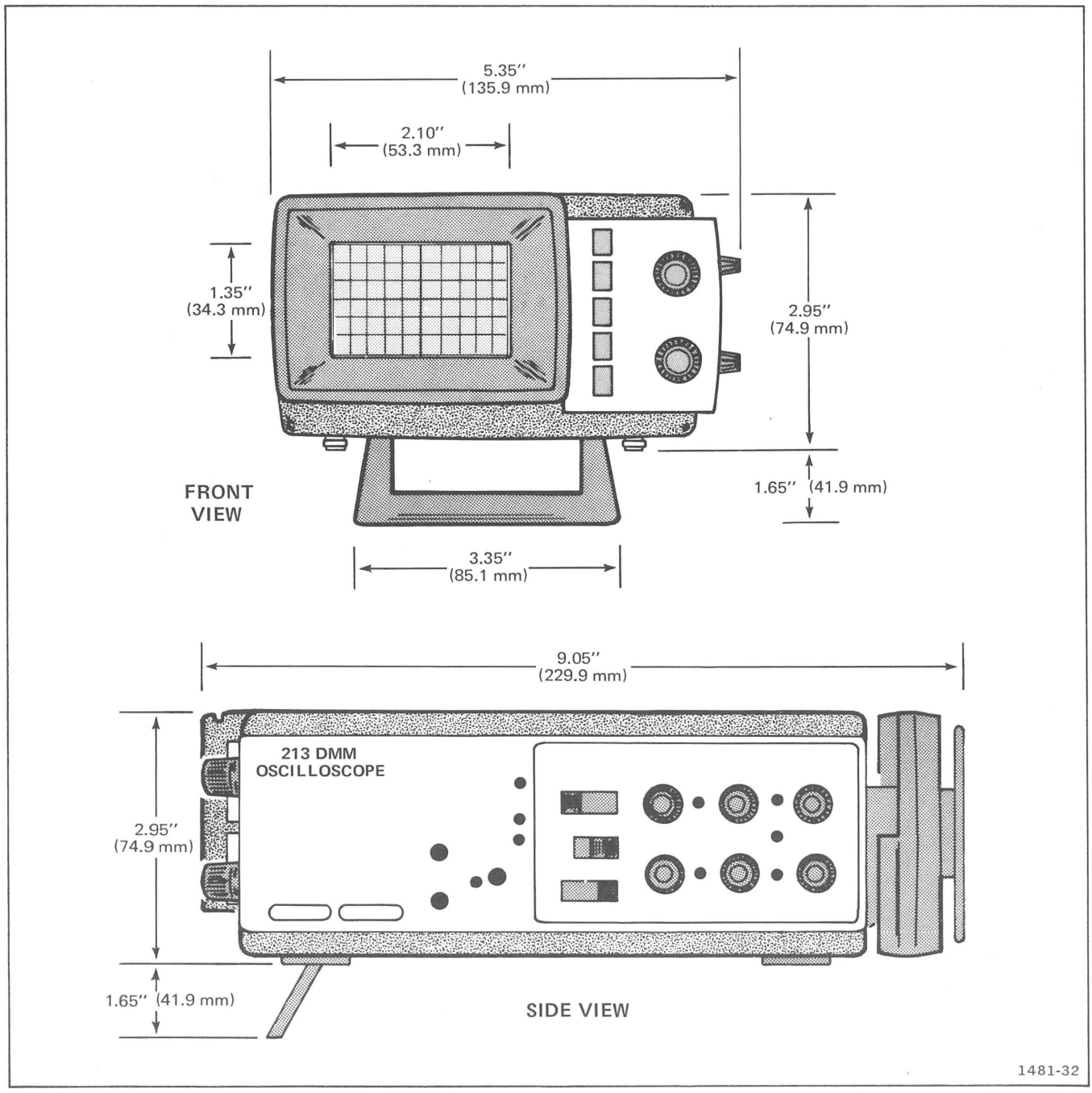



Figure 1-1. Dimensional Drawing.



@

# OPERATING INSTRUCTIONS

## SAFETY INFORMATION

This instrument is designed to allow the input common reference to float above ground. Under this condition, the probe common clip, COMMON input jack, mA-Ω input jack, EXT TRIG jack, and the power plug prongs may be at a dangerous potential. See Table 1-4, Common Isolation Protection in the Specifications section.

When operated on batteries, the power line plug should be stored in the rear-panel insulated compartment. Potentials applied to the common connectors (probe common clip or COMMON jack) may cause small amounts of current to flow in the power-line circuitry creating a possible shock hazard on the plug prongs.

The probe common clip and COMMON jack are electrically connected to each other; therefore, any potential applied to one is present on the other creating a possible shock hazard. Also, to prevent dissimilar voltages being applied to the probe common clip and COMMON jack, which could cause equipment damage, only one should be connected to the circuit under test at any given time. The probe with its common clip, and the mA-Ω input jack with its COMMON jack, should not be connected simultaneously to a circuit under test.

Personal and equipment safety precautions are used throughout this manual and are identified as follows:

Personal Safety — **WARNING**

Equipment Safety — **CAUTION**

## CONTROLS, CONNECTORS, AND INDICATORS

### Side Panel

(1) **mA-Ω**—Banana-jack input for current and resistance measurements. In the Ω mode, this jack is negative with respect to the COMMON jack.

(2) **EXT TRIG**—Banana-jack, high-impedance input for external trigger voltage.

(3) **DC BAL**—Screwdriver adjustment to adjust for minimum trace shift, or change in DMM zero reading, when switching vertical deflection factors or DMM range.

(4) **COMMON**—Banana-jack common return path for current and resistance measurements, or as an alternate reference point or common return when using the voltage probe. It is electrically connected to the probe common clip.

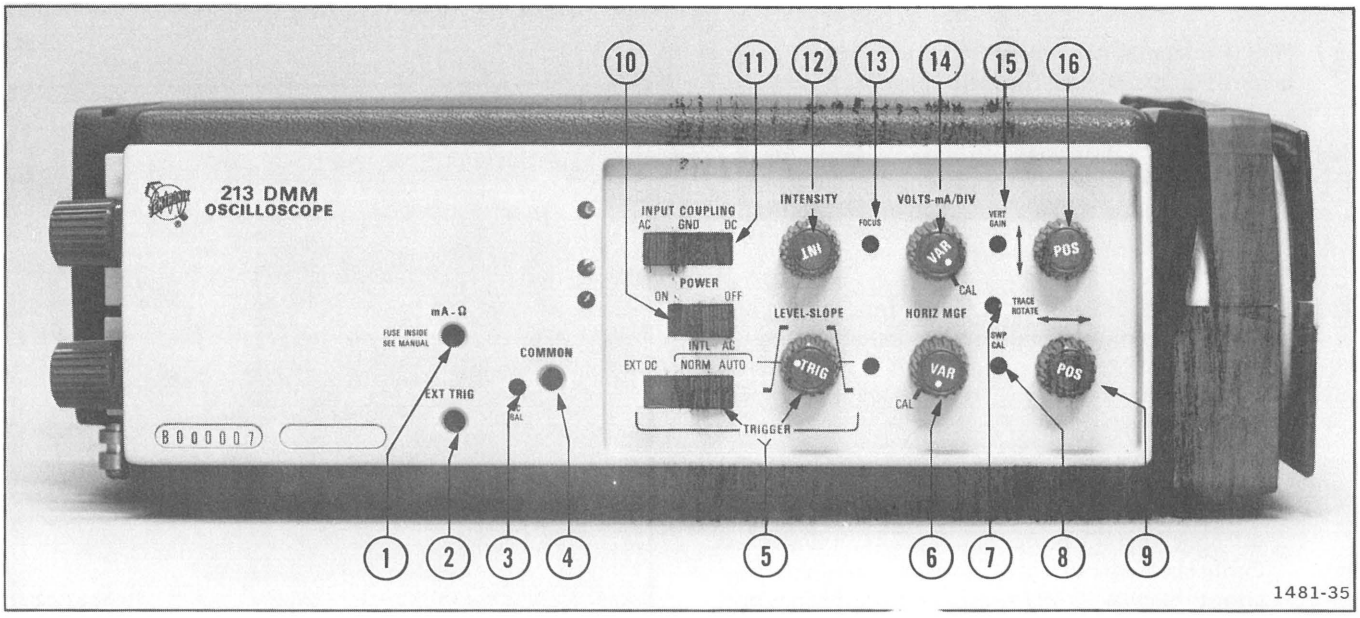



Fig. 2-1. Side panel.

(5) **TRIGGER**—This section contains the trigger mode and level-slope controls.

**EXT DC:** Selects dc coupled external trigger.

**INTL AC NORM:** Selects internal ac coupled trigger signal. There is no trace when the vertical input signal is not sufficient to cause triggering.

**INTL AC AUTO:** Same as INTL AC NORM except the sweep free-runs and provides a bright reference trace when the vertical signal.

**LEVEL-SLOPE:** Selects the amplitude point and slope of the trigger signal on which the sweep is triggered. When the control indicator dot is to the left of center, the sweep is triggered on the positive-going waveform. When to the right of center, the sweep is triggered on the negative-going slope of the trigger signal as shown by the negative-going waveform.

(6) **HORIZ MGF VAR**—Provides continuously variable uncalibrated sweep magnification to at least 5 times the sweep rate indicated by the SEC/DIV control. The calibrated detent is at the fully counterclockwise position.

(7) **TRACE ROTATE**—Screwdriver adjustment to align trace with the horizontal graticule line.

(8) **SWP CAL**—Screwdriver adjustment to set the calibrated sweep timing of the SEC/DIV control when the HORIZ MGF VAR control is in the calibrated detent.

(9) **POS (Horizontal Arrow Line)**—Controls the horizontal position of the oscilloscope display.

(10) **POWER**—Turns instrument on and off. When the instrument is connected to the power line, charging power is provided to the batteries in either position of the switch.

(11) **INPUT COUPLING**—Selects method for coupling of input signal from voltage probe into input amplifier.

**AC:** Signal is capacitively coupled and the dc component is blocked.

**GND:** Connects the input amplifier to common to provide a zero reference voltage without physically disconnecting the probe from the circuit under test. Connects the input signal to the ac coupling capacitor through a 10 MΩ resistor which provides precharging.

**DC:** All components of the input signal are passed to the input amplifier.

(12) **INTENSITY**—Controls brightness of crt display.

(13) **FOCUS**—Screwdriver adjustment to provide optimum display definition.

(14) **VOLTS-mA/DIV VAR**—Provides continuously variable uncalibrated deflection factors to at least 2.5 times the calibrated settings of the VOLTS-mA/DIV control. The calibrated detent is at the fully clockwise position.

(15) **VERT GAIN**—Screwdriver adjustment to set the calibration of the VOLTS-mA/DIV control when the VOLTS-mA/DIV control is in the calibrated detent.

(16) **POS (Vertical Arrow Line)**—Controls the vertical position of the oscilloscope display.

## Front Panel

(17) **VOLTS**—Selects voltage mode for either digital multimeter or oscilloscope function.

(18) **RMS (OUT: DC)**—DMM only. Selects true rms circuitry (button in) or ac rejection filter (button out). Button must be in out position when measuring resistance or the reading accuracy will be degraded.

(19) **DMM (OUT:SCOPE)**—Selects digital multimeter function (button in) or oscilloscope function (button out).

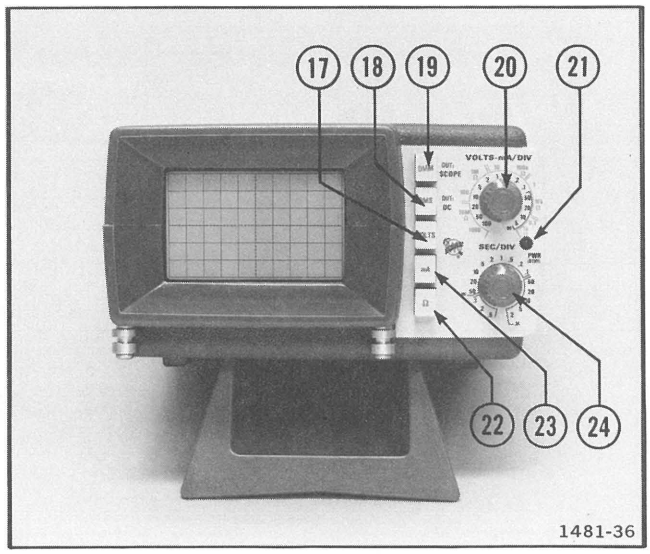



Fig. 2-2. Front panel.

(20) **VOLTS-mA/DIV**—Inner ring (black scale) indicates the calibrated voltage or current vertical deflection factor selected for oscilloscope display when the VOLTS-mA/DIV VAR control is in the CAL detent. Outer ring (blue scale) indicates the full scale range selected for the digital multimeter.

(21) **PWR (BTRY)**—Lights when instrument is on and sufficient battery charge is available. Light extinguishes when battery requires recharging.

(22) Ω—Selects resistance mode for digital multimeter. RMS button must be in the out position when measuring resistance or the reading accuracy will be degraded.

(23) **mA**—Selects current mode for either digital multimeter or oscilloscope function.

(24) **SEC/DIV**—Selects the calibrated sweep rate for the oscilloscope when the HORIZ MGF VAR control is in the CAL detent.

## Rear Panel

(25) **Integral Voltage Probe**—Used by both the DMM and oscilloscope for all voltage measurements. The alligator clip is the common connection.

(26) **Insulated Compartment**—Used to store the power line plug when battery operated.

(27) **Power Cord**—Used when instrument is to be operated on power line voltage or the batteries are being charged. When battery operated, the power line plug should be stored in the rear panel insulated compartment. To store the power cord, wrap the cord in the direction of the arrow located on top of the vinyl cord wrap cover. On the last wrap, store the plug in the insulated compartment.

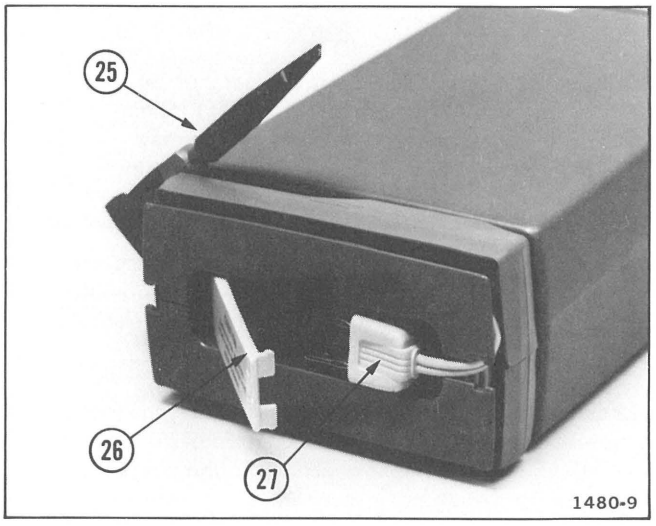



Fig. 2-3. Rear panel.

## PROBE STORAGE

To store the probe, lay the common clip lead parallel to the probe lead, and attach the common clip to the probe lead with the small plastic clip provided on the common clip. Then snugly wrap the leads in the direction of the arrow on the vinyl cord wrap cover (see Fig. 2-4). When the common clip is in position to be wrapped into the bottom side of the storage slot, gently press the common clip down into the slot (see Fig. 2-4) and continue to wrap the leads. As the wrap is completed, carefully guide the probe into its place in the top slot of the vinyl cover (see Fig. 2-3) and gently press the probe down into the slot.

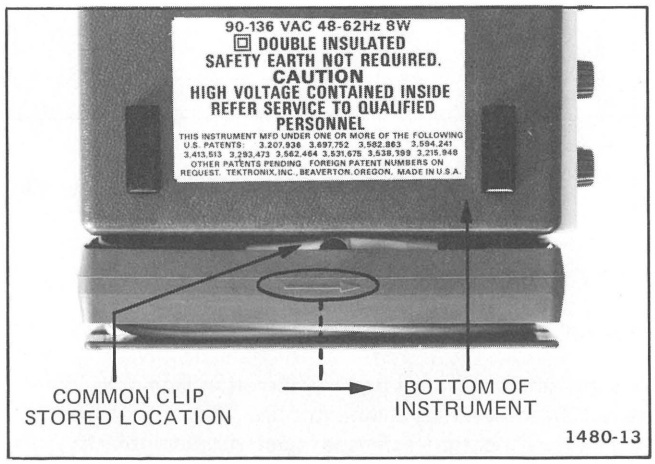



Fig. 2-4. Probe storage.

## PROBE CHARACTERISTICS ON 200-SERIES INSTRUMENTS

On the 200-series instrument probe(s), each probe body assembly is designed to meet the input resistance and attenuation factor for the specific instrument type. These assemblies are not interchangeable between all 200-series instruments; therefore, when more than one type of instrument is being repaired, it is possible for the wrong probe body assembly to become installed on the probe. Figure 2-5 shows how to identify the assembly.

To verify that the proper probe body assembly is installed on the probe, correlate the assembly with the Tektronix Part Number shown in Figure 2-5. Then compare that part number with the correct probe body assembly part number listed in the Mechanical Parts List section.

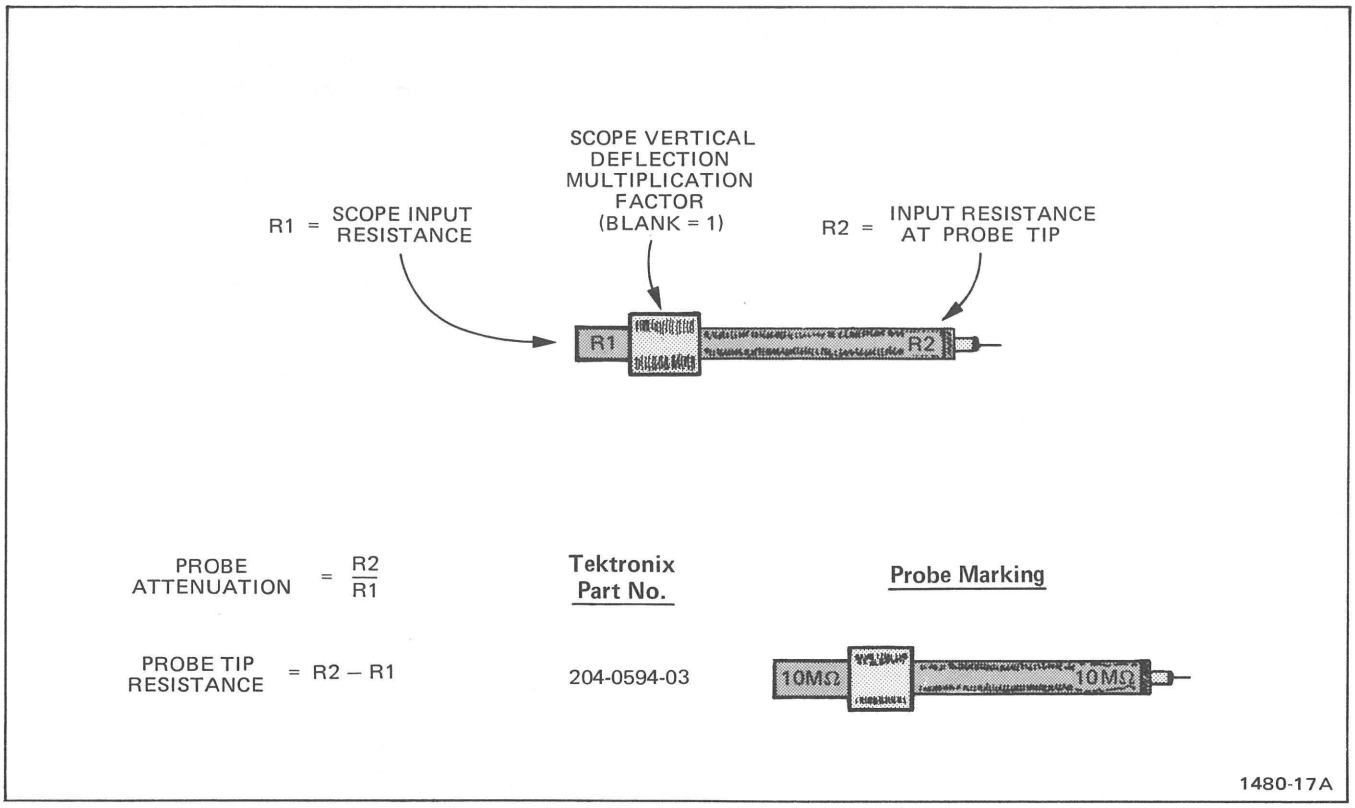



**Fig. 2-5. Probe Body Assembly identification.**

## OPERATING POWER INFORMATION

### Internal Battery Operation

This instrument features battery operation from two internal rechargeable nickel-cadmium cells. The operating time of the internal batteries depends upon display intensity, battery charge and discharge temperature, and the function (DMM or Oscilloscope) being used. When the batteries are charged and operated at +20 to +30°C (+68 to +86°F), the typical operating time of fully charged batteries at maximum display intensity in the DMM mode of operation is 3.5 hours.

A light-emitting diode (LED), labeled PWR (BTRY), indicates that the instrument is on and the battery charge is sufficient for operation. When the battery charge is low, the LED extinguishes. Within 4 to 10 minutes after the LED extinguishes, an automatic battery deep discharge protection circuit will turn the instrument off. This prevents excessive discharge which would result in battery damage.

### Battery Charging

To charge the batteries, connect the instrument to the power line and allow at least 16 hours for the batteries to reach full charge. To obtain the longest operating life for the batteries, the instrument should be turned on at least once a month and the batteries discharged, and then recharged for 24 hours. This procedure balances the charge on the batteries and reduces the possibility of either cell becoming reverse charged. This instrument can be operated while the batteries are being charged.

**NOTE**

If the instrument does not operate with ac power applied, and the PWR (BTRY) indicator does not light, the power line fuse may be blown. See Fuse Replacement in Section 4 for instructions.

The energy capacity of nickel-cadmium cells varies with the temperature at which they are charged and operated. Table 2-1 shows the percentage of full charge capacity at various charging and operating temperatures.

Nickel-cadmium cells will self-discharge when the instrument is not used or is stored for extended periods of time. The rate of self-discharge is dependent upon temperature and humidity. When the instrument is to be stored for extended periods of time, particularly at high temperature or

humidity, the batteries should be charged for at least 16 hours every two weeks, or leave the 213 connected to the power line.

TABLE 2-1
Battery Charge Capacity

| Charging Temperature | Operating Temperature | | |
|---|---|---|---|
| | −15°C | +20 to +30°C | +55°C |
| 0°C | 40% | 60% | 50% |
| +20 to +30°C | 65% | 100% | 85% |
| +40°C | 40% | 65% | 55% |

## Power Line Operation

This instrument can be operated from a power line voltage of 90 to 136 V ac, 48 to 62 Hz. In Option 1, it can be operated from 180 to 250 V ac (48 to 62 Hz) or 180 to 250 V dc.

## Operating Temperature

The 213 can be battery operated in ambient air temperatures between −15 and +55°C (+5 and +131°F). It should be connected to the power line only in ambient air temperatures between 0 and +40°C (+32 and +104°F).

# OPERATORS ADJUSTMENTS AND BASIC DISPLAYS

This section provides instructions for making initial operators adjustments and obtaining commonly used basic displays. Since these procedures involve most of the controls and connectors, they can be used for basic familiarization on the operation of the instrument. Before starting the checkout, either charge the batteries for at least 16 hours or connect the instrument to the power line.

**WARNING**

*When battery operated, store the power line plug in the rear panel insulated compartment. Potentials applied to the common connectors may cause small amounts of current to flow in the power line circuitry creating a possible shock hazard on the power plug prongs.*

**WARNING**

*The probe common clip and the COMMON jack are electrically connected to each other, and potentials applied to one are present on the other, creating a possible shock hazard.*

**CAUTION**

*The probe common clip and the COMMON jack are electrically connected to each other and dissimilar voltages applied to the common clip and COMMON jack can cause equipment damage.*

## Operators Adjustments

The equipment required to make the initial operators adjustments is a screwdriver with a minimum blade size of 3/32 inch. To obtain the basic displays, a dc source, an ac source, and one or two resistors are required. Suggested items for the basic displays are a battery, an audio signal generator, a 3 kΩ resistor, and a 100 kΩ resistor.

1. Set the controls as follows:

| | |
|---|---|
| POWER | ON |
| INPUT COUPLING | GND |
| TRIGGER | AUTO |
| LEVEL-SLOPE | Midrange of either slope (do not set at control midrange) |
| VOLTS-mA/DIV VAR | CAL detent |
| HORIZ MGF VAR | CAL detent |
| POS (both) | Midrange of control |
| DMM (OUT:SCOPE) | Button out |
| RMS (OUT:DC) | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 1 (blue scale) |
| SEC/DIV | .5 m |
| INTENSITY | Minimum for a visible trace |

2. Set the SEC/DIV control to .5 and adjust the FOCUS control (screwdriver adjustment on the side panel) for the

best spot definition (the dot will be slowly sweeping across the screen from left to right).

3. Set the SEC/DIV control to .5 m and adjust the vertical POS control so the trace coincides with the center horizontal graticule line. If the trace is not parallel with this line, set the TRACE ROTATE adjustment (screwdriver adjustment on the side panel) for coincidence.

4. Depress the DMM pushbutton. Alternately switch the VOLTS-mA/DIV control between the 0.1 and 1 volt ranges (blue scale) and check for the same count (approx 0000) and polarity sign in both positions. If they are not the same, set the DC BAL adjustment (screwdriver adjustment on the side panel) for the same count and polarity sign.

## Digital Multimeter Displays

**VOLTAGE MEASUREMENT DISPLAY.** Perform the following procedure to obtain a voltage measurement display:

1. Perform the Operators Adjustments steps.

2. Set the INPUT COUPLING switch to DC, select a VOLTS-mA/DIV range (blue scale) compatible with the amplitude of the dc voltage source to be measured, and connect the dc voltage source between the probe tip and the probe common clip. The display represents the value of the dc voltage source.

3. Reverse the probe tip and common clip connections and note that the numerical reading remains approximately the same but the opposite polarity sign is displayed. Disconnect the dc source.

4. Depress the RMS pushbutton, set the INPUT COUPLING switch to AC, select a VOLTS-mA/DIV range (blue scale) compatible with the amplitude of the ac voltage source to be measured, and connect the ac voltage source between the probe tip and probe common clip. The display represents the value of the ac voltage source. Set the RMS pushbutton to the out position and note that the average dc value of the ac signal is zero verifying that the ac filter is operational. Disconnect the ac signal.

**CURRENT MEASUREMENT DISPLAY.** Perform the following procedure to obtain a current measurement display:

5. Depress the mA pushbutton, set the RMS pushbutton to the out position, and select a VOLTS-mA/DIV range (blue scale) compatible with the amplitude of the current generated by the dc voltage source in series with the current limiting resistor. Connect the dc voltage source in series with the current limiting resistor, and connect this combination between the mA-Ω jack and the COMMON jack with test leads. The display represents the value of the dc current. Disconnect the dc source and resistor.

6. Depress the RMS pushbutton and select a VOLTS-mA/DIV range (blue scale) compatible with the amplitude of the current generated by the ac voltage source and a series current limiting resistor. Connect the ac voltage source in series with the current limiting resistor, and connect this combination between the mA-Ω jack and the COMMON jack with test leads. The display represents the value of the ac current. Disconnect the ac source and resistor.

**RESISTANCE MEASUREMENT DISPLAY.** Perform the following procedure to obtain a resistance measurement display:

7. Depress the Ω pushbutton and set the RMS pushbutton to the out position. Select a VOLTS-mA/DIV range compatible with the value of the resistor to be measured and connect the resistor between the mA-Ω jack and COMMON jack with test leads. The display represents the value of the resistor.

**OVERRANGE DISPLAY.** Perform the following procedure to obtain an overrange display:

8. Disconnect the resistor and the display shows an overrange condition.

## Oscilloscope Displays

**NORMAL SWEEP DISPLAY.** Perform the following procedure to obtain a normal sweep display:

1. Perform the OPERATORS ADJUSTMENTS steps.

2. Set the DMM pushbutton to the out position and INPUT COUPLING switch to AC. Select a VOLTS-mA/DIV range (black scale) compatible with the amplitude of the ac voltage source to be applied and connect the ac voltage source between the probe tip and probe common clip. Select a SEC/DIV range for the desired display and adjust the LEVEL-SLOPE control for a stable display.

3. Rotate the VOLTS-mA/DIV VAR control counterclockwise out of its calibrated detent and observe the reduction in the vertical size of the display. Return the control to the CAL detent.

4. Set TRIGGER switch to INTL AC NORM and rotate the LEVEL-SLOPE control to obtain a stable display at some position on both slopes of the control. Reset the TRIGGER switch to INTL AC AUTO.

**MAGNIFIED SWEEP DISPLAY.** Perform the following procedure to obtain a magnified sweep display:

5. Adjust the horizontal POS control to move the display to be magnified to the center portion of the crt. Turn the HORIZ MGF VAR control clockwise out of its calibrated detent and adjust the display for the desired amount of magnification. Return the control to its CAL detent. Disconnect the ac source.

# THEORY OF OPERATION

This section of the manual contains a description of the circuitry used in the 213 DMM-Oscilloscope. The description begins with a discussion of the instrument using the Block Diagram pullout page in the Diagrams section. Then, each circuit is described in detail using additional detailed diagrams and the schematics in the Diagrams section. The detailed diagrams contain the same component designations as the schematics; therefore, refer to the schematics for component electrical values and relationships. The schematic being described is identified by its Diagrams section number (e.g. ◇2◇ ) following the first paragraph title that begins the description of a particular schematic.

## DIGITAL LOGIC

Digital logic techniques are used to perform some functions within this instrument. The function and operation of the logic circuits are described using logic symbology and terminology. All logic functions are described using the positive logic convention. Positive logic is a system of notation where the more positive of two levels is called the true, HI, or 1 state and the more negative level is called the false, LO, or 0 state. The HI-LO method of notation is used in the logic descriptions in this manual. The specific voltages which constitute the HI or LO state may vary between individual devices.

It should be noted that not all of the integrated circuit devices in this instrument are digital logic devices. The function of non-digital devices are described individually using detailed diagrams or other techniques to illustrate their functions.

Table 3-1 contains the logic symbol and truth table for the logic device used in this instrument.

## BLOCK DIAGRAM DESCRIPTION

The following discussion is provided to aid in understanding the overall concept of the 213 DMM Oscilloscope before the individual circuits are discussed in detail. Refer to the Block Diagram pullout page in the Diagrams section.

Signals to be displayed on the crt are applied to either voltage probe or the mA-Ω input jack. Both inputs are shared by the DMM and oscilloscope functions.

The signals are then coupled and attenuated (voltage inputs) or converted to voltages (current and resistance) and amplified by the Input Buffer Amplifier. From this amplifier the signal goes to either the DMM or Oscilloscope function.

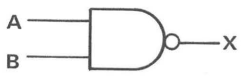
In the DMM function, a two-pole, low-pass active filter provides ac rejection and is switch selected when measuring dc.

This allows the DMM to provide a true average response to dc measurements when the source being measured contains both a dc and an ac component.

The Gm Converter rectifies bipolar ac signals into a unipolar current to drive the RMS Converter, or A/D Converter. The RMS Converter changes the rectified signals into a unipolar current of equivalent rms value to drive the A/D Converter.

The A/D Converter changes the unipolar current into a binary coded decimal (BCD) output to drive the Character Generator. The Character Generator accepts the BCD input and converts it to X, Y, and Z signals to drive the Output Amplifiers and Z-Axis Amplifier which cause crt deflection and blanking to create the readout display.

**TABLE 3-1**
**NAND Gate Logic Chart**

| | | | |
|---|---|---|---|
| NAND gate<br><br>U250A, B, C, & D |  | A device with two or more inputs and one output. The output of the NAND gate is LO if and only if all of the inputs are at the HI state. | Input / Output<br>A \| B \| $\overline{X}$<br>LO \| LO \| HI<br>LO \| HI \| HI<br>HI \| LO \| HI<br>HI \| HI \| LO |

In the Oscilloscope function the input signal is further amplified by the Scope Preamplifier, which provides vertical gain switching, variable gain control, and positioning. The resultant signal drives the Vertical Output Amplifier which causes vertical crt deflection to create a display.

The Sweep Generator produces a linear sawtooth sweep signal for horizontal deflection. It is triggered internally from a portion of the vertical input signal, externally from a separate trigger source, or free-runs in an internal ac automatic mode of operation during the absence of an adequate internal signal level. The output of the sweep generator is amplified by the Horizontal Output Amplifier which causes horizontal crt deflection to create a linear sweep. The Sweep Generator also generates a signal to the Z-Axis Amplifier for display blanking and unblanking.

All voltages required to operate the instrument are provided by a battery operated power supply, which is recharged by an integral battery charger when connected to the power line.

## CIRCUIT DESCRIPTION

Unless otherwise specified, the following detailed circuit descriptions will make reference to the schematic diagrams in the Diagrams section at the rear of this manual.

### ATTENUATOR & INPUT AMPLIFIER ◇1

The input section consists of the voltage and current-resistance inputs and input switching; voltage input coupling and attenuation; the current shunt resistor network; the Ohms Converter; and the Input Buffer Amplifier.

#### Input Switching

Input switching is accomplished by a combination of physical input connections and self-cancelling pushbuttons. Voltage inputs are made from the probe tip through probe input P100, while current and resistance inputs are made through J120. Switch S160 selects the type of input (voltage, current, or resistance); connects the appropriate voltage attenuator, current shunt resistor, or the Ohms Converter with its scaling resistor network; and connects the selected input to the Buffer Amplifier.

#### Voltage Coupling and Attenuation

Voltage inputs from P100 are coupled to the attenuator through INPUT COUPLING switch S100. In the DC position of S100, all signals present at the probe enter the attenuator. In the AC position, the dc signals are blocked by C101 and only the ac signals enter. In the GND position of S100, the Buffer Amplifier side of S100 is grounded to provide a ground reference without physically disconnecting the probe to ground it. In this position, the input coupling capacitor, C101, is precharged through R101 to ground.

The signal enters the attenuator section and passes through without attenuation or is attenuated by 1000:1, 100:1, or 10:1, depending upon the position of the S120 switch contacts. When contact 18 is open and 16 is closed, 10:1 attenuation is provided by R108, R109, and their associated series-parallel components. When contact 21 is open and 19 is closed, 100:1 attenuation is provided by R103, R106, and their associated series-parallel components. When both contacts 18 and 21 are open, and 16 and 19 are closed, 1000:1 attenuation is provided. When 18 and 21 are closed, and 16 and 19 are open, there is no attenuation. Resistor pairs R103-R106 and R108-R109 are precision matched pairs. Capacitors C104, C108, and C112 provide attenuator frequency compensation. The output of the attenuator is connected or disconnected from the Buffer Amplifier input by the VOLTS section of S160.

#### Current Shunt Resistors

Current inputs are connected between the mA-Ω jack, J120, and the COMMON jack, J125. When the current mode is selected by S160, an input voltage for the Buffer Amplifier is generated by current flow through combinations of resistor network R115, R117, and R118 as selected by S120. Clamping diodes CR118 through CR121 and fuse F161 provide input protection in the current mode.

#### Ohms Converter

Figure 3-1 is a detailed block diagram of the Ohms Converter circuitry.

Resistance inputs share input connectors J120 and J125 with the current input. When S160 is in the OHMS mode, a constant current source is connected to J120, and resistance is measured by passing a constant current through, and measuring the voltage across the unknown resistance. This measured voltage, which is directly proportional to the unknown resistance, becomes the input voltage to the Buffer Amplifier.

The Ohms Converter circuit consists of a precision current generator Q214 and Q215, an operational amplifier U175C, and the range scaling resistors R120 through R123.

U175C is connected to the feedback summing junction of the Buffer Amplifier; therefore, its inverting and non-inverting inputs are at the same input voltage as the input of the Buffer Amplifier. The precision current generator provides a 0.5 milliampere current (adjusted by R215 during calibration) through R165 which establishes and maintains a 1 volt drop across that resistor. This voltage drop keeps the output of U175C at 1 volt more negative than the potential at J120, which is the input to the Buffer Amplifier. The

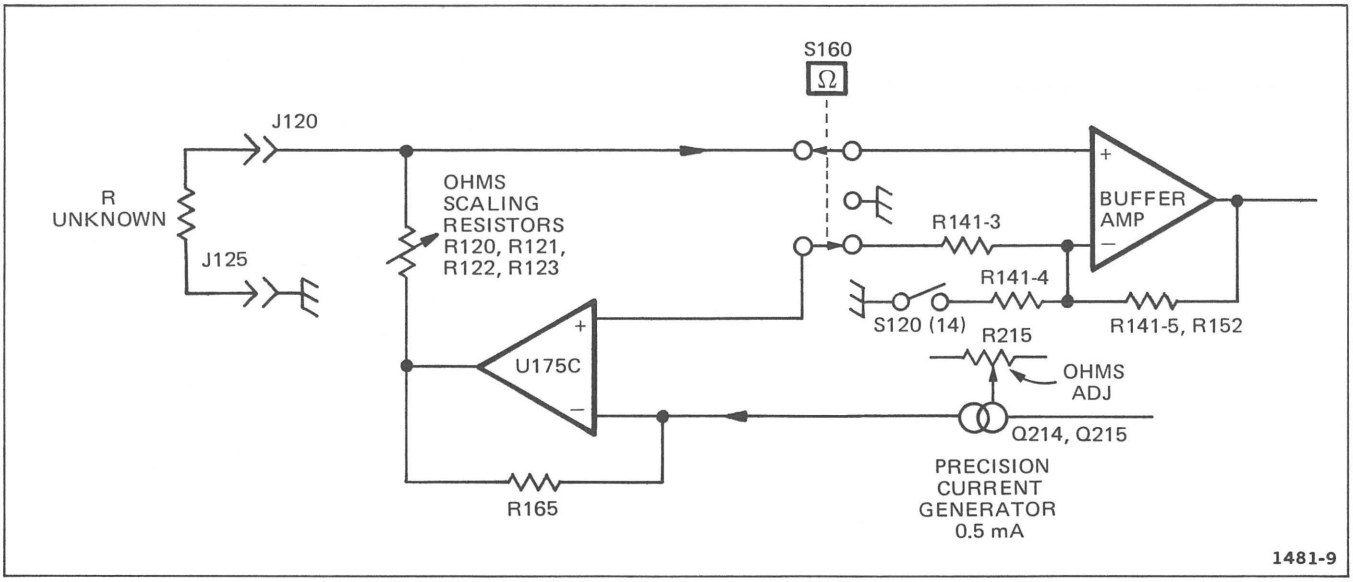



**Fig. 3-1. Ohms Converter detailed block diagram.**

output of U175C is connected to J120 through switched resistors R120 through R123. This 1 volt differential between the Buffer Amplifier input and the output of U175C is constant regardless of the scaling resistor selected; therefore, a constant current is always applied to the unknown resistance. This results in a voltage input to the Buffer Amplifier that is proportional to the unknown resistance. The Ohms Converter is protected against overvoltage by VR165 and series resistors R120 through R123.

### Input Buffer Amplifier

The Buffer Amplifier consists of a matched dual FET input, Q145; a common base stage, Q142 and Q144; a current mirror, Q140 (A circuit whose characteristic is such that whatever current flows in one path, an equal current also flows, or is mirrored, in the other path); a Darlington amplifier, Q150 and Q154; and an emitter follower, Q155. These circuits combine to form a one times or ten times gain operational amplifier type circuit. Q146 and Q156 are current sources.

The input is through R140 and R142, which, in conjunction with the low reverse current clamping diodes CR142 and CR143, provide input protection against overvoltage. C142 reduces the ac attenuation effects of this protection circuitry.

Amplifier feedback is from the emitter of Q155 through R152 and R141-5 to the inverting input of the amplifier. This feedback sets the current flow through Q145B, Q144, and Q140B. As Q140 is a current mirror, whatever current flows in Q140B also flows in Q140A, thus setting the signal level at the base of Q150. One times or ten times gain is controlled by the grounded or ungrounded condition of R141-4. When grounded, only 10% of the output is fed back to the inverting input giving the Buffer Amplifier a closed loop gain of 10, which is adjusted by R152 during calibration. When R141-4 is not grounded, all of the output is fed back and the amplifier has unity gain. The buffer amplifier operates at 10 times gain on the 5 and 10 millivolt ranges, the 1 kilohm range, and on all current ranges.

The output of the buffer amplifier is connected to either the DMM or oscilloscope function by S155, which also applies operating voltages to the selected function. The output also goes to the overrange and clamping circuitry which is discussed later.

## DIGITAL MULTIMETER FUNCTIONS ◇2◇ ◇3◇

### Active Filter

U175B and its associated circuitry is an operational amplifier configured as a low-pass two-pole active filter. It is selected by S185 in the dc measuring mode and removes the ac component from the signal before it enters the Gm Converter. When in the rms measuring mode, C179 is switched across R179 to improve the high frequency response into the Gm Converter.

### Gm Converter

The function of the Gm Converter is to generate an output current that is proportional to the absolute value of the input voltage. For ac signals the Gm Converter converts the bipolar input voltage to a unipolar output current. The main components are operational amplifiers U180 and U186; transistors Q180, Q185, and Q188; diode CR187; and resistor R184.

With a positive input to the converter, the Q185 end of R184 is maintained at the positive input voltage by U180 and Q185, while the opposite end of R184 is maintained at zero volts by U186 and CR187. This voltage appearing across R184 sets the output current which appears at the collector of Q185.

With a negative input to the converter, R184 has a negative input voltage at its Q180 end and zero volts maintained at the opposite end by U186 and Q188. This voltage appearing across R184 sets the output current which appears at the collector of Q188.

R186 and C186 provide high frequency compensation. CR183 through CR185, C183, and R183 shift the operating point of U180 to provide more dynamic range for the converter. C181, C182, C187, and C188 are compensation capacitors for U180 and U186.

## RMS Converter

The RMS Converter accepts the absolute value current input from the Gm Converter and changes it to a dc current which is proportional to the true rms value. Operating voltage is provided only when the DMM function is selected by S155, and is connected into the circuitry only when the rms feature is selected by S185. Figure 3-2 is a detailed block diagram of the RMS Converter showing how the rms value is derived. The RMS Converter is composed of an input current splitter, a gain cell (A variable transconductance amplifier that supplies an output current proportional to its input voltage), an averaging circuit, a current mirror, and an output current inverter.

Operation of the current splitter, Q198, depends upon its matched pair devices for which a given emitter-base voltage will result in the same collector current in each device. Q196 provides for beta compensation.

Transistor Q192 and Q194 make up a gain cell whose operation is dependent upon their matched pair devices, the logarithmic characteristics of their emitter-base junction, and feedback from Q190A and Q190B. In this configuration the ratio of the collector current of Q194A to the collector current of Q194B is the same as the ratio of the collector current of Q192B to the collector current of Q192A. Integrated circuit U188 is used to vary the offset voltage around the loop of Q194 and Q192, and also serves as an rms gain control.

The current from Q194A is averaged by C190 and R190 in the current mirror, U175A and Q190, and the voltage developed sets the operation of U175A. The output of U175A sets the voltage across R191 which controls the current through Q190A. The current through Q190A is used to balance the gain cell and, when balanced, this current is equal to the rms value of the input current. Since Q190 is a current mirror, this same current appears in Q190B and appears at the input to the inverter.

The output current inverter, U175D, divides its input current by a factor to correct for the ratio of R190 and R191, and for losses in the input current splitter. Inversion is accomplished by using the inverting input of the operational amplifier and amplification is set by the ratio of R198 and R199. Resistors R194, R195, and R197 provide offset adjustment and CR197 prevents circuit latch-up if the offset is adjusted such that the output would go negative. CR199 keeps the output from being fed to the A/D Converter if it goes negative. Q195 detects crest factor overrange, and is part of the overrange circuitry which is covered later.

## A/D Converter

Figure 3-3 is a detailed block diagram of the A/D Converter which consists of a DMM reference, an integrator, a threshold detector, a converter latch, a counter, and a clock generator.

The A/D Converter operates on the modified dual-slope integration principle which provides accuracy independent of supply voltage and component changes. Modified means

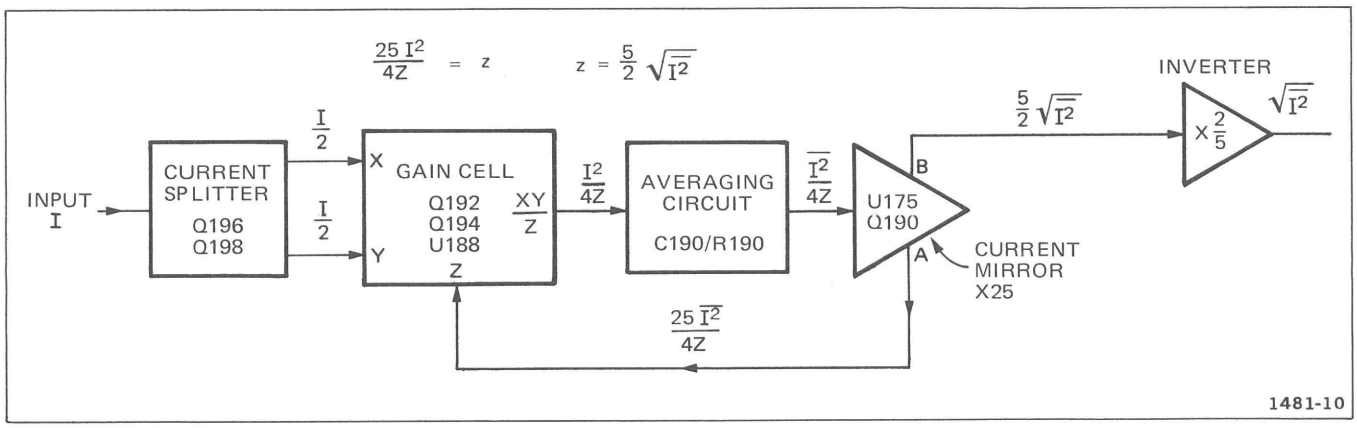



Fig. 3-2. RMS Converter detailed block diagram.

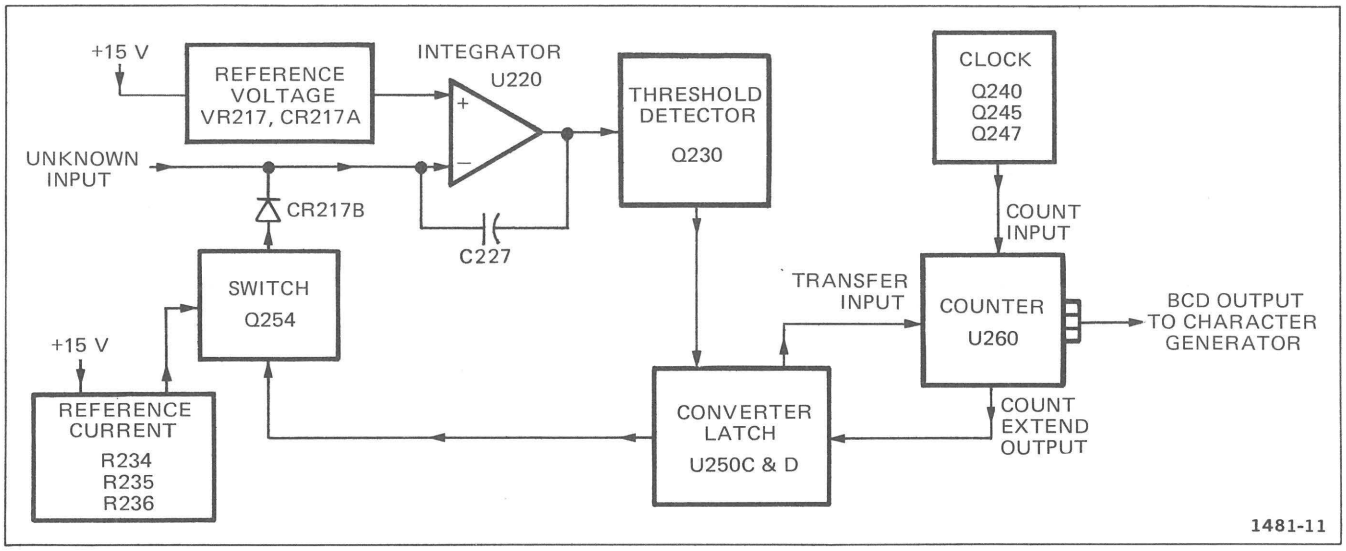



**Fig. 3-3. A/D Converter detailed block diagram.**

that the unknown potential is applied at all times and not switched off during capacitor discharge. A current directly related to the unknown input is applied to an integrator which causes a ramp. When the counter reaches the trailing edge of the 9999 count, a reference current of the opposite polarity causes a ramp in the opposite direction. When the opposite ramp begins, the counter is at 0000. When the integrated waveform reaches a negative threshold, the number in the counter is stored as BCD data, and the reference current is turned off. Upon receiving a scan input command, this stored BCD count is forwarded to the Character Generator and subsequently displayed as the value of the measured input.

The DMM reference consists of VR217, CR217A, CR217B, R235, and R236. Temperature-stable zener diode VR217 generates a reference voltage (with respect to the +15 V power supply), which is filtered and applied to the positive input of the integrator U220. This voltage also appears at the negative input of U220 and across resistor string R235 and R236, which causes current flow through them and CR217B when Q254 is not conducting. Q254 acts as a switch to turn the reference on and off. When Q254 is conducting, CR217B is reverse biased and the current flow is through Q254 instead of CR217B, which essentially disconnects the reference from U220. Rectifier CR217A is used to temperature compensate CR217B. During the DC Zero calibration adjustment, R234 increases the A/D Converter sensitivity by a ratio of about 10 to 1.

Refer to the A/D Converter timing diagram, Figure 3-4 and the schematic diagrams for the remainder of the A/D Converter description.

Emitter coupled multivibrator Q240 and Q245, generates a clock pulse of approximately 70 kilohertz which is applied through buffer Q247 to pin 7 of the four decade counter U260. During the count, C227 is ramping in the positive direction in response to the unknown input. After the counter reaches a count of 9999, pin 8 of U260 is pulsed HI and then falls LO on the trailing edge of the next clock pulse at which time the counter returns to count 0000. The trailing edge of the pulse from pin 8 is differentiated by Q258, C258, R258, R252, and R253, and appears as a LO pulse at pin 9 of U250C. A LO at pin 9 of U250C causes a HI on pin 8 which turns Q254 off, and a HI on pin 13 of U250D causes pin 11 to go LO. Pin 9 of U250C returns HI at the end of the differentiated pulse from pin 8 of U260 which causes no change. With Q254 turned off, the reference current causes U220 to integrate both the input and reference currents as a negative ramp. When the negative ramp goes low enough to turn on CR230 and Q230, pin 12 of U250D goes LO. This LO at pin 12 causes a HI at pin 11, a HI at pin 10 of U250C, and a LO at pin 8 of U250C, which turns Q254 on. Also, this LO is differentiated by C255 and R255 and applied to pin 5 of U260 which causes the BCD count of the counter to be transferred to a storage register (latch) where it remains for display until the next transfer pulse. Whenever pin 9 of U260 receives a negative pulse from pin 1 of U270, the BCD data is transferred serially to the Character Generator one character at a time. As each character is transferred, the output from pins 1, 2, 3, and 4 of U260 provides spacing current to the horizontal amplifier through Q260, Q262, Q264, and Q266. This spacing current establishes the horizontal position on the crt where each character is displayed.

## Character Generator

The Character Generator is a Tektronix integrated circuit device that provides X, Y, and Z signals to the crt deflection system to form the numerical readout display. The Character Generator provides X and Y signals to form the seven

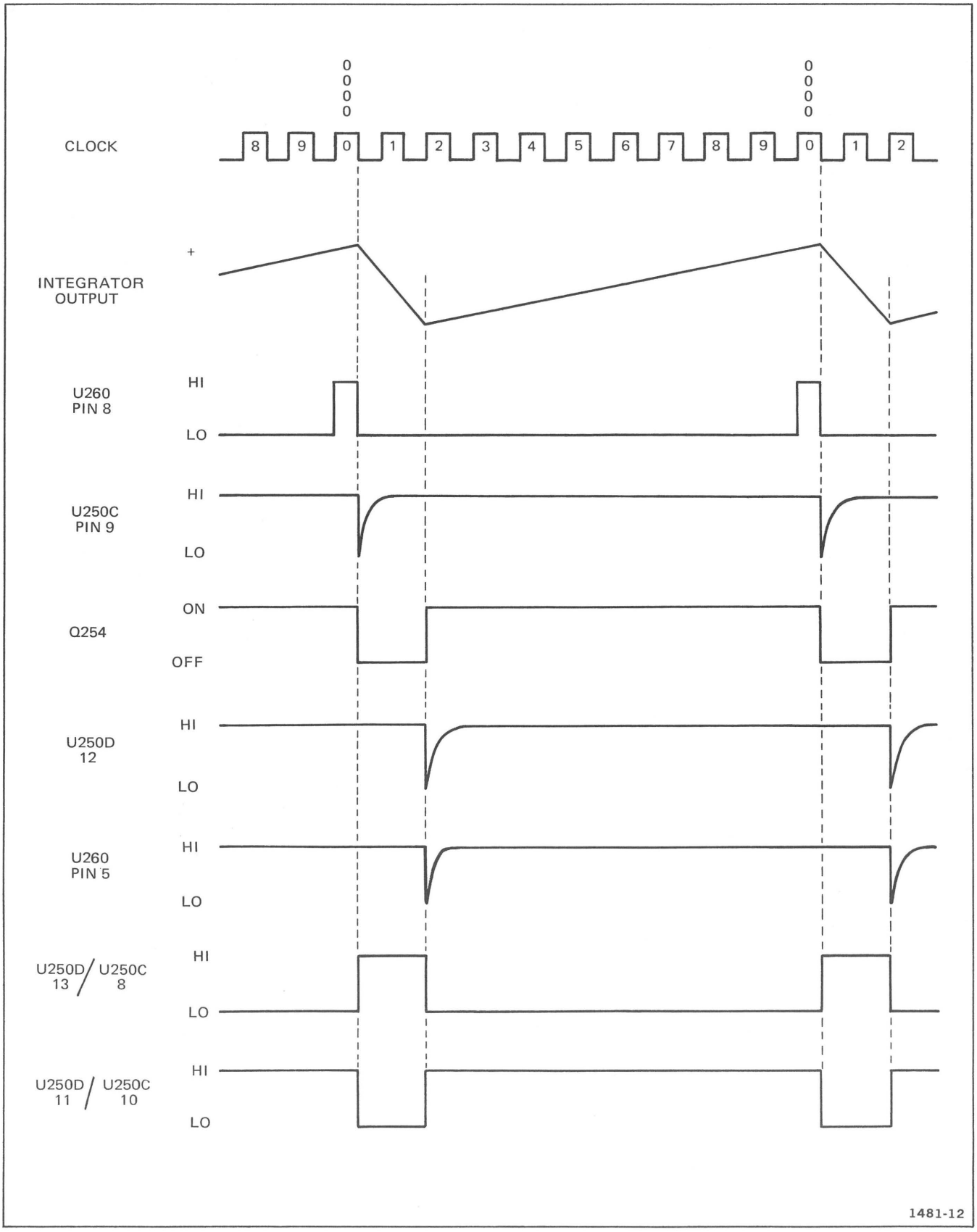



Fig. 3-4. A/D Converter timing diagram.

segment digital display character 8. Internal blanking signals form the plus or minus sign and the decimal point. To form each of the digital display characters 0 through 9, the Character Generator converts the serial BCD data from pins 10, 11, 12, and 13 of U260 into Z-Axis (or blanking) Output signals. The Z-Axis signals blank one or more of the segments of the character 8 to form the other characters. The current through Q278, which is gated by Q275 and set by S120 contacts 5 and 6, causes the decimal point to be positioned properly on the crt.

Table 9-2 shows the relationship between one displayed character and the BCD output of U260. The BCD data consists of four groups of BCD data (one group for each character); therefore, this relationship can be measured (with a voltmeter) only when one of the four characters is the number to be measured and the other three characters are 0's.

Figure 3-5 shows the relationship between one displayed character and the Z-Axis Output from U270. This output, like the BCD data, is repeated four times (once for each character) and can be measured (with an oscilloscope) only when one of the four characters is the number to be measured and the other three characters are 0's.

## Polarity Sign Control

The voltage at pin 14 of U270 controls the sign on the display. Approximately 0.7 volts negative causes a positive sign, while about 0.7 volts positive causes a negative sign. A positive 6 volts will turn the sign off.

In the rms mode of operation when RMS pushbutton S185 is selected, a positive 6.5 volts is applied through R267 and turns the sign off.

In the ohms mode of operation, S160 applies a current to the base of Q182 which causes it to saturate and apply a positive 6.5 volts through R267, again turning the sign off.

In the Gm Converter a positive input causes a negative 0.7 volts to appear at pin 6 of U186, which causes a positive sign. A negative input causes a positive 0.7 volts to appear at pin 6, which causes a negative sign.

## Overrange Circuitry

For the following description, refer to the Overrange Circuitry Simplified Schematic Diagram, Fig. 3-6, and the Overrange Timing Diagram, Fig. 3-7.

The overrange indication, that appears on the readout display as scrambled character segments or 8's, is caused by a negative unblanking signal at the input to the Z-Axis Amplifier Q390, which prevents blanking of the unused char-

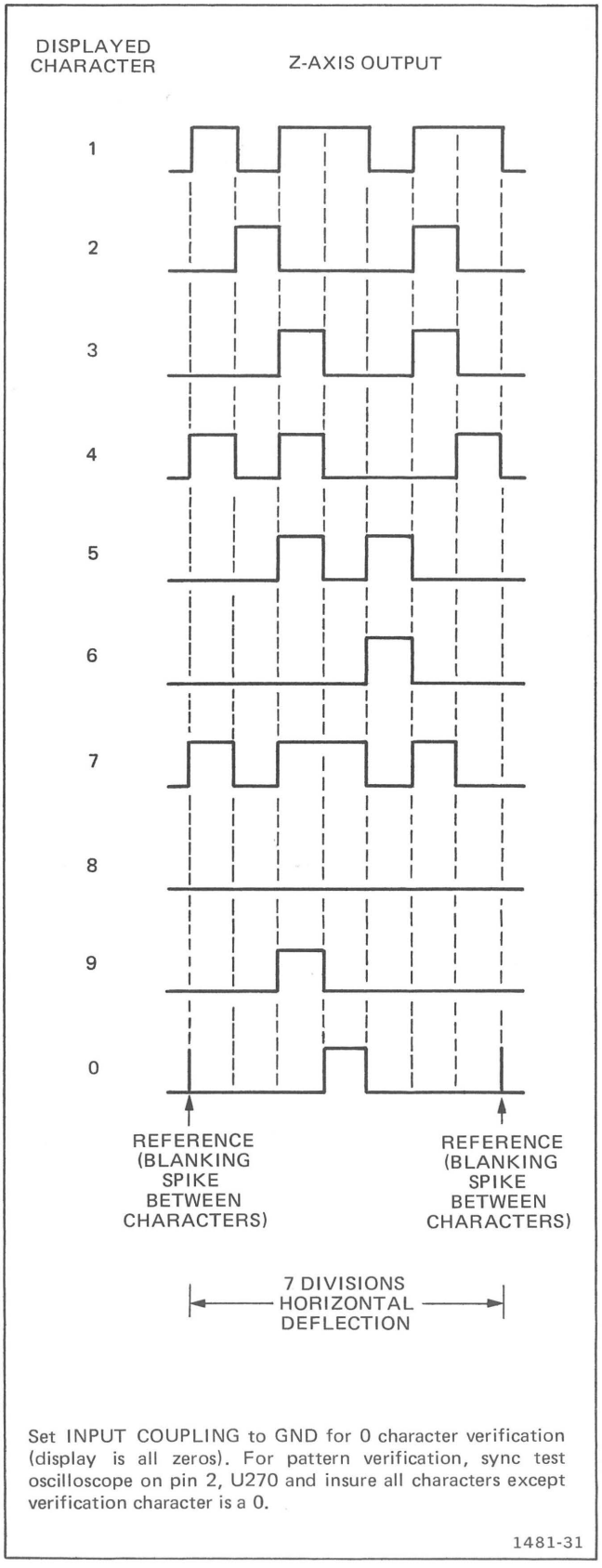



**Fig. 3-5. Character Generator Z-axis output.**

acter segments. This negative unblanking signal is established by the overrange detector, Q204; overrange latch U250A and B; and the transistor switch, Q256. These are in turn controlled by the overrange circuitry in the Buffer Amplifier, RMS Converter, and A/D Converter.

Buffer Amplifier positive overrange is controlled by CR157, CR158, Q158, R163, and R166; while negative overrange is controlled by CR156, CR159, Q159, R164, R167, and Q162. Resistors R163-R166 and R164-R167 establish the operating threshold on their respective transistors. When-

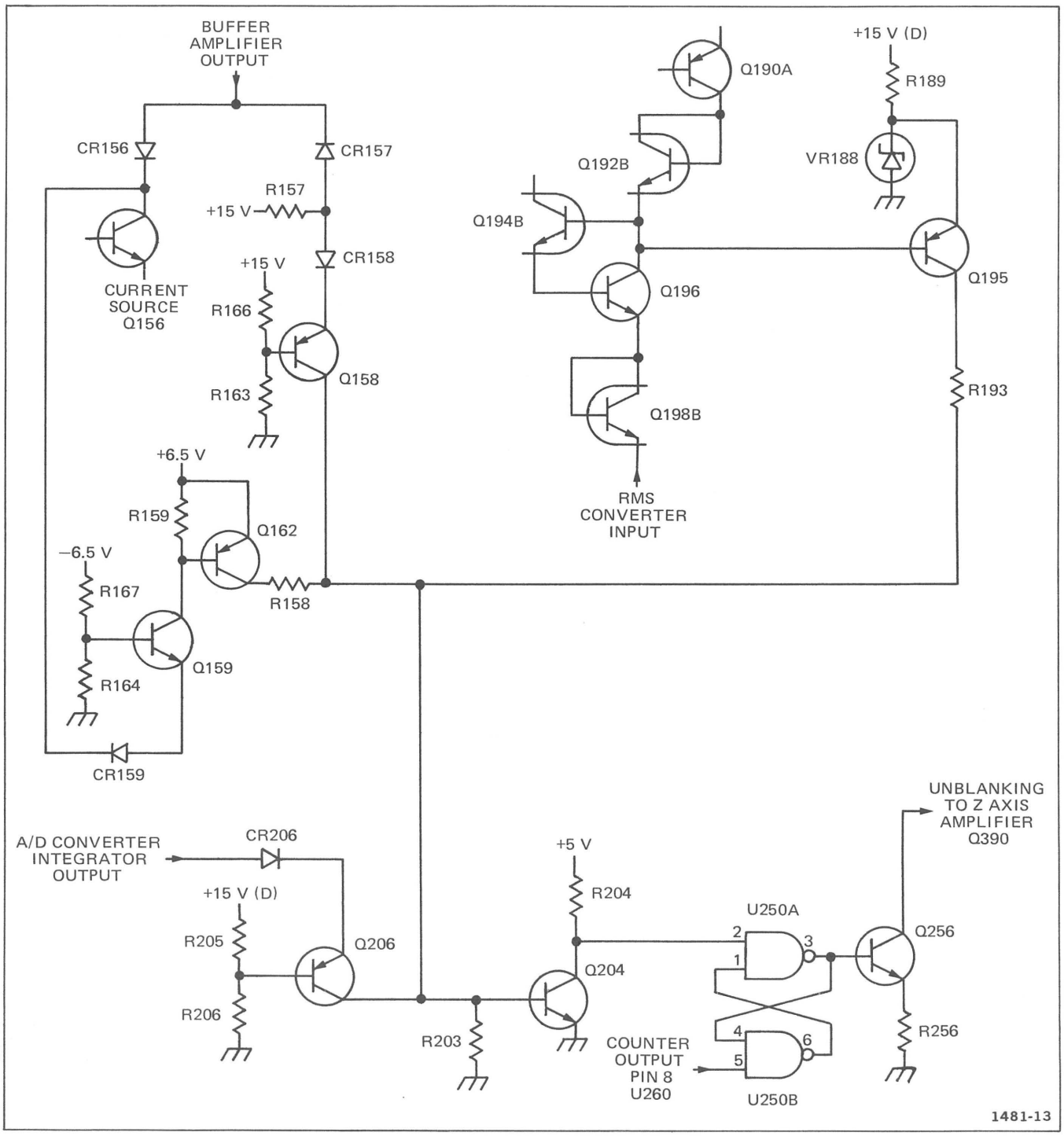



Fig. 3-6. Overrange circuitry simplified schematic diagram.

ever either of these thresholds is exceeded, current flow increases in the associated transistor which causes Q204 to turn on. Q157 acts as a clamp to prevent the Buffer Amplifier output from going negative enough to saturate Q156.

RMS Converter overrange occurs whenever the crest factor ratio is exceeded. When this happens, Q195 turns on and causes Q204 to turn on.

In the A/D Converter, R205 and R206 set a positive threshold for Q206. Whenever this threshold is exceeded by the positive ramp from U220 there is increased current flow in Q206 which causes Q204 to turn on.

When Q204 turns on, pin 2 of U250A goes LO, pin 3 goes HI, and Q256 turns on which causes a negative unblanking signal to appear at the input of Q390. As long as the overrange condition remains, the count 0000 reset pulse from pin 8 of U260, which is applied to pin 5 of U250B, cannot reset the overrange latch. As soon as the overrange condition disappears, pin 2 of U250A goes HI. On the next reset pulse, pin 1 goes HI, pin 3 goes LO, Q256 turns off, and the overrange indication disappears.

## OSCILLOSCOPE FUNCTIONS ◇1◇ ◇4◇

### Preamplifier

The Oscilloscope Preamplifier is a simple feedback amplifier consisting of Q170, Q172, and Q174. The input signal is developed across the 1-2-5 gain switching resistor network R128, R129, and R178. Amplifier gain is set by R130, R132, R133, and feedback resistor R174. Vertical signal positioning is controlled by current from R135 through R134. This current changes the voltage across R174 thus providing position control without affecting amplifier gain. The Preamplifier output drives the vertical amplifier section and provides an internal vertical signal to the trigger circuit when selected by S315.

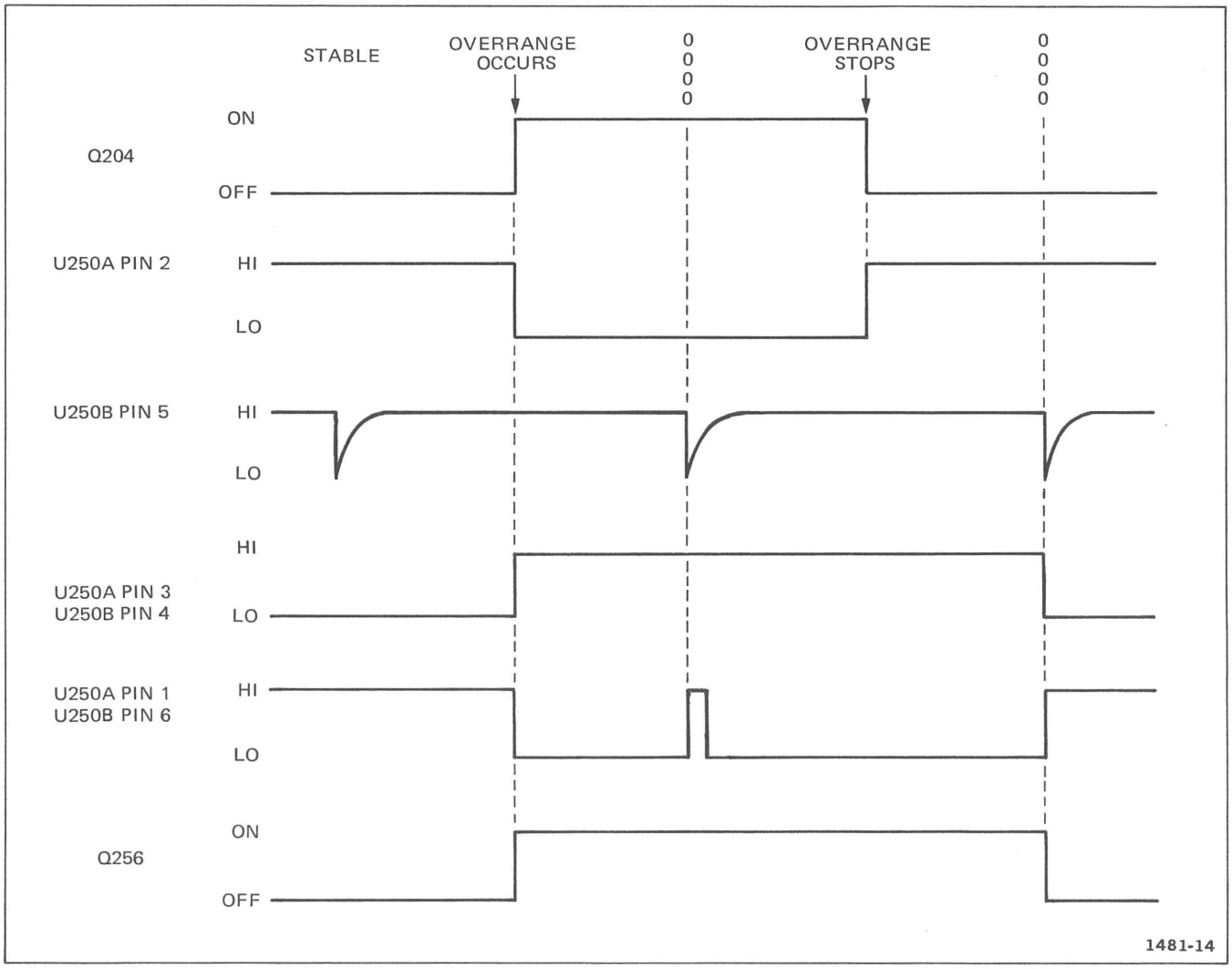



Fig. 3-7. Overrange timing diagram.

### Sweep Generator and Trigger

Integrated circuit U335 is a combination trigger and sweep generator. The trigger input sources are either internal or external as selected by S315. External trigger signals applied through J315 are dc coupled through a 10:1 attenuator network consisting of R314, R315, C314, and C315. Internal trigger signals are derived from a sample of the Oscilloscope Preamplifier output and are ac coupled through C316. The triggering level, and the slope at which triggering occurs, is set by R316. CR332 and CR333 provide input protection to U335.

The sweep generator portion of U335 is a Miller integrator that generates a linear sawtooth output waveform. Its slope is controlled by the setting of S300, and is calibrated by R312. The ratio of R330 and R332 sets the sweep length to about 12 divisions. When the generator is triggered from an internal source, it operates either in a normal or automatic mode depending on the voltage at pin 15 of U335. In the normal mode of operation a negative 5 volts is applied to pin 15, and when the input signal is not sufficient to cause triggering there is no trace. In the automatic mode the negative 5 volts is removed, and when the input signal is not sufficient to cause triggering the sweep free-runs at a rate set by C334. Pin 4 of U335 provides an unblanking gate signal coincident with the sawtooth waveform. This gate controls the Z-Axis Amplifier and provides crt unblanking during the horizontal sweep. C327 and C328 establish the sweep holdoff time.

## OUTPUT SECTION ◈4

### Vertical Output Amplifier

The Vertical Output Amplifier section consists of an output amplifier driven by one of two differential amplifiers, one for the digital multimeter function and the other for the oscilloscope function.

The Y signal from the Character Generator drives the digital multimeter vertical differential amplifiers Q350 and Q355. They are turned on when S355 applies voltage to the emitters and bases, and their gain, which sets the vertical size and position of the characters, is controlled by R352 and R354.

The vertical signal from the Oscilloscope Preamplifier drives the oscilloscope vertical differential amplifier Q346 and Q348. This amplifier is turned on by Q347 and Q374 which operates when S355 applies voltage to them. Q347 is a current source for the amplifier and its base voltage is set by Q374, a temperature compensated voltage supply.

The Vertical Output Amplifier directly provides the crt vertical deflection voltages and consists of transistors Q340 and Q345 whose output is inductively peaked by L340 and L344. Rectifiers CR350 and CR355 prevent saturation of the output amplifier.

### Horizontal Output Amplifier

The Horizontal Output Amplifier section consists of a horizontal output amplifier driven by a differential amplifier for the digital multimeter function or a differential amplifier for the oscilloscope function.

The X signal from the Character Generator drives the digital multimeter horizontal differential amplifier Q380 and Q385. Transistors Q380 and Q385 are turned on when S355 is in the DMM mode, which applies voltage to their emitters and bases. Amplifier gain, which controls the horizontal size of the characters, is set by R382 and R384, whose ratio also sets the horizontal position of the characters. A portion of the vertical signal from the Character Generator Y output is fed to Q385 through R358 to cause a slight tilt in the numerical readout display giving it a more pleasing appearance.

The sweep generator output drives the oscilloscope horizontal differential amplifier consisting of Q366, Q368, Q370, and U365A through U365E. Transistors Q366 and Q368 are turned on by Q370 and Q374 which operate only when S355 applies voltage to them. The horizontal position of the signal is determined by a current ratio between Q366 and Q368 that is set by R378 which controls the base voltage on Q368. Amplifier gain is set by the ratio of R366 and R368 to R360 and R364. Magnifier gain is controlled by integrated circuit U365 operating as a gain cell whose current gain is controlled by the voltage on the bases of U365E and Q370. The magnifier gain is set by the ratio of the current through R372 to the current through R366 and R368 minus the current through R365 and R369. The current ratio of U365A through U365D follows the signal input; therefore, the gain cell maintains a constant magnifier gain setting.

The horizontal output amplifier provides the crt horizontal deflection voltages and consists of high voltage transistors Q340 and Q345. Rectifier CR360 keeps Q360 from saturating.

### Z-Axis Amplifier

The Z-Axis Amplifier (or unblanking amplifier) consists of VR395, Q390, and Q394. When an unblanking gate from the Sweep Generator or Character Generator is present at the base of Q390, it turns off and Q394 turns on. When Q394 turns on, a positive voltage set by VR395 causes the crt to unblank (or turn on). Q394 is a speedup device which supplies additional current to unblank the crt more rapidly.

## CRT CIRCUIT ◈6

The crt is a Tektronix designed standard battery operated oscilloscope device which has its phosphor modified to enhance the DMM readout function.

The crt filament current is rated for operation within a plus or minus 5 percent tolerance. Since the power supply is a pulsed inverter type, direct connection of the filament to the inverter transformer would result in supply current variations greater than 5 percent. Inductor L537 provides a series impedance which varies with the supply frequency and keeps the supplied current within the required 5 percent tolerance.

The cathode of the crt is the directly heated type and is maintained at −1000 volts plus or minus 1 percent by the high-voltage power supply.

FOCUS control R565 is used to compensate for differences between individual crt's and has an adjustable range of about 200 to 340 volts more positive than the cathode. VR535 holds one end of R565 at −800 volts while current through R530 and R532 set the other end of R565 at about −600 volts. When the INTENSITY control is set so the crt is cut off, the focus circuit draws about 90 microamperes. The Astigmatism control R575 is used in conjunction with the FOCUS control to adjust for the best spot definition.

Intensity control for the crt is provided by R560. Its operating potential is provided by the difference between the seventh and eighth stage of high voltage multiplication which is about 175 to 185 volts. When the intensity grid (pin 3, V560) is approximately 105 volts more negative than the cathode, the crt will be cut off. Since grid characteristics vary from crt to crt, R535 is added as a means of limiting beam current. When R560 is set for maximum intensity, R535 is set for a maximum beam current of 200 microamperes. This is accomplished during calibration by measuring the voltage across R527. With a beam current of 200 microamperes and a focus current of 90 microamperes, there would be a voltage drop of 0.29 volts across R527. To prevent exceeding the beam current of 200 microamperes, R535 is actually set for a 0.28 volt drop across R527.

The crt has an internal graticule; therefore, trace alignment is accomplished internally with R570 and a coil around the outside of the front portion of the crt. R570 sets the current through the coil which establishes a magnetic field. This field interacts with the crt beam and allows the trace to be rotated on the crt axis about 1 degree beyond level in either direction.

Blanking is accomplished with blanking deflection plates, and R580 is used to properly center the beam when the crt is unblanked. When blanked, the plate connected to the Z-Axis Amplifier is at about +7 volts causing all beam current to be absorbed by that plate. When unblanked, the Z-Axis Amplifier plate os at about +47 volts as set by VR395. Resistor R580 is also set at about +47 volts; therefore, the beam is centered which causes unblanking.

Deflection is accomplished with internal deflection plates driven directly by the vertical and horizontal output amplifiers. Each graticule division of vertical deflection requires about 12.8 to 14.1 volts difference between the plates, while each graticule division of horizontal deflection requires about 8.2 to 9.2 volts difference between the plates.

## POWER SUPPLY ◇5◇ ◇6◇

The power supply consists of the batteries, an inverter, a regulator, a low-voltage shutdown circuit, a low-voltage rectifier-filter section, and a high-voltage power supply. From the 2.4 volts provided by a pair of nickel-cadmium cells, operating voltages of 0.6 volts ac, and +6.5, −6.5, +15, +75, and −1000 volts dc are produced. The +15 volts, which is used throughout the instrument as a reference, is the most critical, and is regulated within 1 percent. Whenever battery voltage falls to a predetermined level, below which battery damage may occur, a low-voltage shutdown circuit causes instrument shutdown.

### Inverter and Regulator

The inverter is a switching regulator type and consists of Q460, Q465, Q470, Q474, Q475, Q480, Q484, Q486, Q488, and T490. Refer to the detailed block diagram of the power supply, Figure 3-8, for the following explanation of switching regulator operation. Switch transistor Q488 is turned off and on by the pulsed waveform duty cycle from the astable multivibrator Q470 and Q475, which is controlled by the +15 volt supply. When Q488 is turned on, current flow through the primary of T490 causes an energy build up. When Q488 turns off, this energy build up collapses which causes a flyback effect that transfers energy to the secondary of T490. The amount of energy built up is proportional to the on-time of Q488 in relation to its cycle time which is controlled by the frequency of the astable multivibrator. The frequency of the multivibrator is set by the amount of current flow through the switching regulator, which is controlled by the voltage at the +15 volt output. Refer to the power supply schematic for the remainder of the inverter description.

As battery voltage decreases, the operating voltages also decrease. Any decrease in the +15 volt supply is reflected at the base of Q465 reducing its current flow, which causes a corresponding reduction of current flow in Q474. Reduced current flow in Q474 increases the discharge time of C470 which increases the off-time of Q470 and Q480. This increases the on time of Q488 and allows a higher energy build up in T490. When this high energy build up collapses, the transferred energy is higher, thus returning the operating voltages to their proper level which is initially set during calibration by R467.

The approximate operating frequency of the astable multivibrator is 60 kilohertz at the highest battery voltage and 20 kilohertz at the lowest battery voltage. The on-time of Q470 (or off-time of Q488) remains fairly constant at about

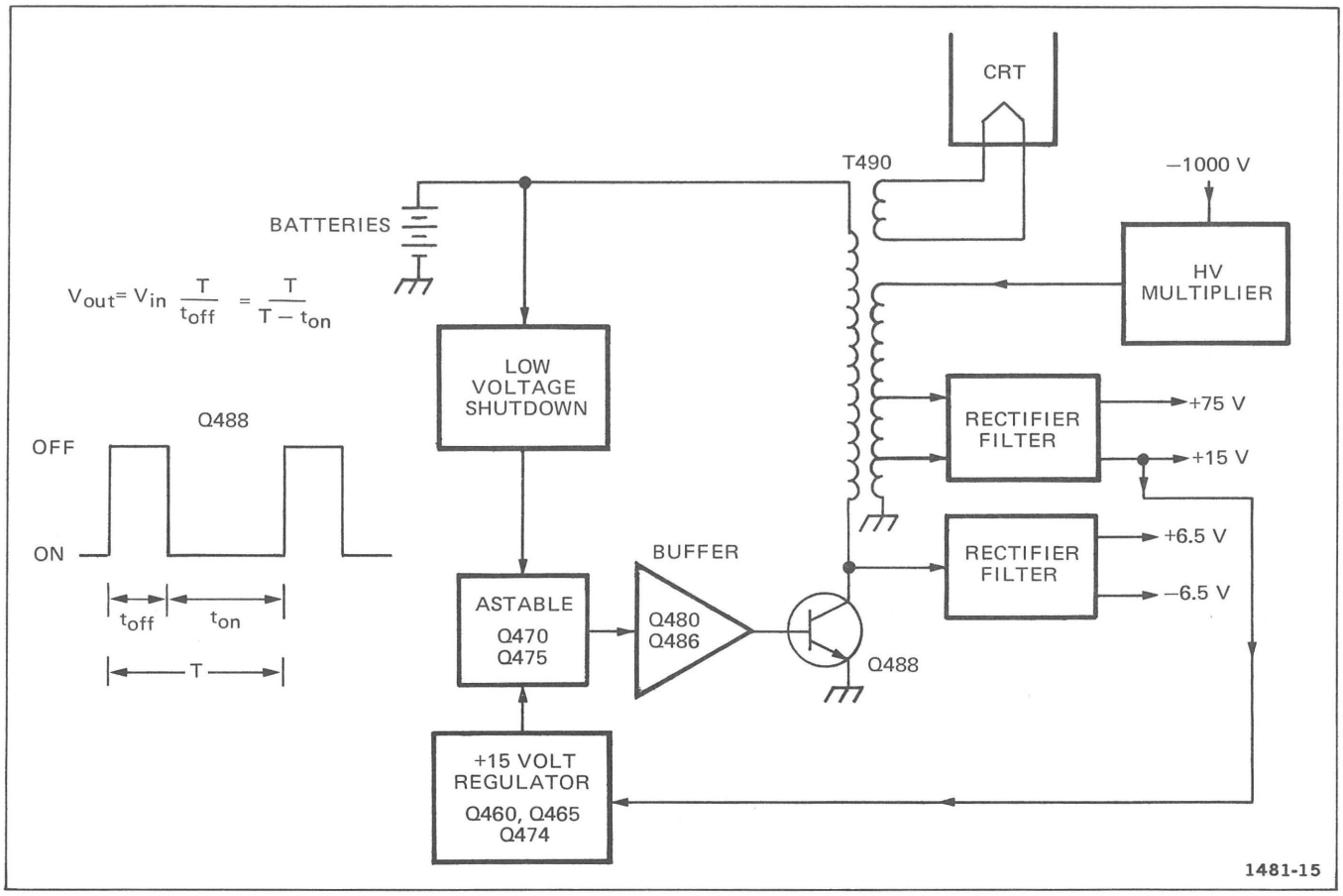



**Fig. 3-8. Power Supply detailed block diagram.**

10 microseconds. Q484 operates when Q486 is turned off, and it is used to remove the store charge at the base of Q488 to make it turn off quicker. CR472 and C472 prevent the multivibrator from blocking, which would prevent it from oscillating when initially turned on.

## Low-Voltage Shutdown Circuit

The low-voltage shutdown circuit operates as a battery condition indicator and battery deep-discharge protector. The light-emitting diode (LED) labeled PWR (BTRY) is controlled by this circuit, and indicates a low battery level when it is not lit and the instrument is turned on. If the instrument is not turned off when the LED extinguishes on a low battery level, this circuit terminates instrument operation. This protects the batteries against damage that could be caused by deep discharge.

When the battery is fully charged and the instrument is turned on, pin 2 of U450 is about +2.4 volts and pin 3 is about 2.12 volts. This causes a negative output from U450 which turns CR450 on, but does not affect SCR Q458.

When the battery voltage falls below +2.12 volts, the output of U450 begins to rise and CR450 turns off. The battery voltage continues to decrease until it reaches about +2.02 volts, at which time the output of U450 reaches about +4.5 volts and CR454 starts to conduct. This provides positive feedback to U450 and causes its output to rapidly increase toward +15 volts. The rapid increase in the output of U450 causes a positive step on the gate of Q458 that turns it on, which effectively grounds the junction of R470 and R473, and causes the oscillation of the astable multivibrator to stop. When the multivibrator stops oscillating, all power supply voltages collapse and the instrument stops operating. Q458 remains on until the POWER switch is turned OFF and then ON to reset Q458.

## LOW-VOLTAGE RECTIFIER-FILTER ◈6

All low-voltage power supply voltages begin as outputs from T490 except the ±6.5 V supplies. When flyback of T490 occurs, approximately 7 volts is present at the collector of Q488 which is rectified and filtered to produce the ±6.5 volts. The +15 and +75 volt outputs of T490 are rectified and filtered by conventional networks.

CR543, CR544, CR552, and CR554 are hot carrier diodes which provide low power dissipation because of reduced

junction voltage. This provides a faster recovery time at the multivibrator frequency that results in an increase in the overall efficiency of the power supply. C544 prevents a 700 to 800 hertz self-oscillation by the power supplies which could otherwise be caused by the feedback circuitry.

## HIGH VOLTAGE ◈6

High voltage is generated by an 8 stage multiplier that takes about 190 volts peak to peak from the secondary of T490 and produces approximately 1300 to 1400 volts across the multiplier. The crt accelerating voltage, which is obtained after the seventh stage of multiplication, is adjusted to exactly −1000 volts by R525 and regulated to within 1 percent by Q525, Q527, and Q528.

In a stable condition with the intensity turned all the way down, 90 microamperes of focus current flows in the high-voltage section through VR535, R565, R530, R532, R537, Q527, Q525, and the multiplier. Transistor Q528 is a constant current source which is adjusted to a nominal 10 microamperes by R525 and held stable by a zener-diode regulated +9 volt supply. When 10 microamperes of current flows through R528, the supply is set at −1000 volts. Also, a negative gate voltage is applied to Q527 where its drain-to-source transfer characteristics allow the 90 microamperes of focus current to flow.

When intensity is turned up, load current increases, which causes the −1000 volt supply to decrease. This decrease reduces the negative gate on Q527, which causes an increased current flow through it and the multiplier, and returns the −1000 volt supply to its set level. A decrease in load current would cause the opposite effect, thus a constant −1000 volts is maintained.

Since the regulator is the feedback type, C525 prevents self-oscillation. The first 8 capacitors in the multiplier have a mylar dielectric which increases supply efficiency at low temperatures.

## BATTERY CHARGER ◈5

The battery charger consists of a line input section, battery charger converter, and a battery charger regulator.

### Line Input

The line input section contains a line filter consisting of all components from the power-line plug through C412, and a Power-Line Rectifier.

The Power-Line Rectifier consists of CR412, CR413, CR414, CR417, C418, L417, and L418. This section acts as a voltage doubler and rectifier when operating on 90 to 136 volts ac. In Option 1, the section acts as a bridge rectifier when operating on 180 to 250 volts ac, and as a dc filter when operating on 180 to 250 volts dc. Its output is approximately 330 volts dc which operates the Battery Charger Converter.

### Battery Charger Converter

The battery charger converter is frequency controlled with the battery charge current regulated by the control transformer T423.

Transistors Q422 and Q424 form a power converter. Feedback through R427 and pins 4 and 5 of T423 maintains oscillation at a frequency near the LC resonant frequency established by C427 and the primary of T430. When operating near the resonant frequency, the output voltage of the secondary of T430 is about 3 to 4 volts peak. When this voltage is rectified and filtered by CR434, CR435, C436, and L435, it causes the batteries to charge.

The converter transistors Q422 and Q424 are not regenerative when first turned on; therefore, CR426, a bidirectional negative-resistance breakdown diode, is added to provide a start pulse. As C425 begins to charge through CR425, a point is reached where breakdown of CR426 occurs and pulses Q424 into operation.

### Battery Charger Regulator

As the battery charge increases to about 350 milliamperes, the voltage developed across R447, which is sensed by Q444, is sufficient to cause an increase in current through Q442 and pins 6, 7, 8, and 9 of T423. This increased current flow changes the permeability of T423, which effectively reduces its inductance and raises the operating frequency of the converter. As the converter frequency shifts away from resonance, the output voltage from T430 decreases and thus reduces the charge rate.

CR427 and CR428 are flyback diodes which catch stored energy in the LC resonant circuit to improve efficiency. CR421, CR422, CR423, and CR424 are protection devices for Q422 and Q424. Rectifiers CR421 and CR423 prevent a short circuit of the supply by insuring that one transistor is off before the other turns on. CR422 and CR424 prevent forward biasing of the collector-base junction during the flyback period. R423 and C423 prevent feedback oscillation in the drive transformer. VR440 prevents charger runaway should the batteries be disconnected while the charger is in operation. When the charger reaches the breakdown voltage of VR440, current flows through the T423 control windings and drives the converter off resonance which reduces the output voltage. CR430 and CR432 provide a negative supply voltage to operate Q442 and Q444.

# MAINTENANCE

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, or troubleshooting of the 213. It also includes repackaging information.

## TEKTRONIX FIELD SERVICE

Tektronix, Inc. maintains repair and recalibration facilities at its local Field Service Centers and the Factory Service Center. For further information or assistance, contact your local Tektronix Field Office or representative.

## PREVENTIVE MAINTENANCE

Preventive maintenance consists of recalibration, cleaning, visual inspection, and lubrication. Preventive maintenance, performed on a regular basis, can prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the instrument is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

### Recalibration

To insure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every 6 months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed or corrected by recalibration.

### Cleaning

The 213 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path which may result in instrument failure. The cabinet provides protection against dust in the interior of the instrument and operation without them necessitates more frequent cleaning.

**CAUTION**

*Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. In particular, avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents. Recommended cleaning agents are isopropyl alcohol (Isopropanol) or ethyl alcohol (Fotocol or Ethanol).*

**EXTERIOR.** Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. The brush is particularly useful for dislodging dirt on and around the controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

**INTERIOR.** Dust in the interior of the instrument should be removed occasionally to prevent undesirable electrical conduction. Clean the interior with a dry, low-velocity stream of air. If this method doesn't remove all the loose dust, or if hard dirt is present, the boards will have to be disassembled for further cleaning. A soft bristle brush or a cotton tipped applicator is useful for cleaning in narrow spaces or for cleaning the more delicate components.

If the boards are disassembled for thorough cleaning, the high-voltage circuits, particularly parts located in the high-voltage multiplier, and the thick film input attenuator resistors should receive special attention. Excessive dirt or dust in these areas may cause high-voltage arcing, or signal-path shunting, which would result in improper instrument operation.

**CATHODE-RAY TUBE (CRT).** Clean the plastic light filter and the crt face with a soft, lint-free cloth dampened with denatured alcohol.

### Visual Inspection

The 213 should be inspected occasionally for such defects as broken connections, improperly seated semiconductors, damaged or improperly installed circuit boards, and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

### Lubrication

Generally, there are no components in the 213 that will require lubrication during the life of the instrument.

**PUSHBUTTON SWITCHES.** These switches are lubricated prior to leaving the factory and should not require further lubrication. However, if they become electrically noisy, cleaning and lubricating with Electronic Chemical Corporation No Noise® may resolve the problem.

**CAM SWITCHES.** In most cases the factory lubrication of these switches should be adequate for the life of the instrument. If the switch has been disassembled for replacement of switch sub-parts, General Electric Versilube® silicon grease may be used and applied sparingly so that the lubricant does not get on the contacts. Refer to Figure 4-1 for the following lubrication instructions (instruction numbers are also lubrication point locators on the figure):

1. Apply lubricant to the drum journals and mating surface in the mounting bearings.

2. Apply lubricant to the wear surface of the index wheel.

3. Apply lubricant to the index roller and roller guide in the front bearing. A thin film should be applied to the inner face of the detent springs if more than one spring is replaced.

4. Ensure that some lubricant is present at the interface between the bearing and retainer clip.

## CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques that are required to replace components in this instrument are given here.

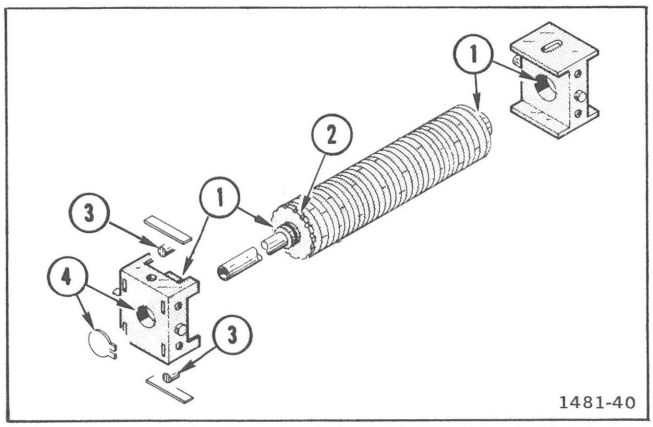



**Figure 4-1. Typical cam switch lubrication points.**

### Obtaining Replacement Parts

**STANDARD PARTS.** All electrical and mechanical part replacements for the 213 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

**NOTE**

*Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.*

**SPECIAL PARTS.** In addition to the standard electronic components, some special components are used in the 213. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the parts list by the Tektronix, Inc. manufacturer code (80009) listed in the Mfr Code column. Most of the mechanical parts used in this instrument, except miscellaneous hardware, have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

**ORDERING PARTS.** When ordering replacement parts from Tektronix, Inc., it is imperative that all of the following information be included in the order to ensure receiving the proper parts.

1. Instrument type (include mod or option numbers).

2. Instrument serial number.

3. The complete description line from the parts list (Ckt No., Tektronix Part No., Serial/Model No., etc).

### Soldering Techniques

**WARNING**

*Before soldering, turn the instrument off, disconnect it from the power line, and allow approximately 3 minutes for the filter capacitors in the power supply to discharge. If the instrument*

*has been connected to the power line with the power-line filter plug (P420) disconnected from the battery charger, C417 and C418 will remain charged until P420 is connected to the charger or discharged by the grounding method.*

**CAUTION**

*Some of the circuit boards in this instrument are multi-layer type boards with conductive paths laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the interconnections between the layers. Only experienced maintenance personnel should attempt repair of these boards.*

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques that apply to maintenance of any precision electronic equipment should be used when working on this instrument. Ordinary 60/40 rosin-core electronic-grade solder and a 15-watt soldering iron is adequate for most soldering in the 213. Should a larger wattage soldering iron be required on some of the metal shields or larger common connection circuit pads, use a 35-watt or 40-watt pencil-type soldering iron.

After soldering is completed, clean the area around the solder connection with isopropyl or ethyl alcohol. Be careful not to remove any information printed in the area.

## Component Removal and Replacement

Since component removal and replacement requires instrument disassembly, replacement procedures for the batteries, crt, and circuit boards will be explained first. These replacement procedures are written so that in most cases, each preceding component must be removed before the following component is removed (e.g. the batteries must be removed before the A/D Converter Board is removed). The location of each circuit board is shown in Figure 4-2.

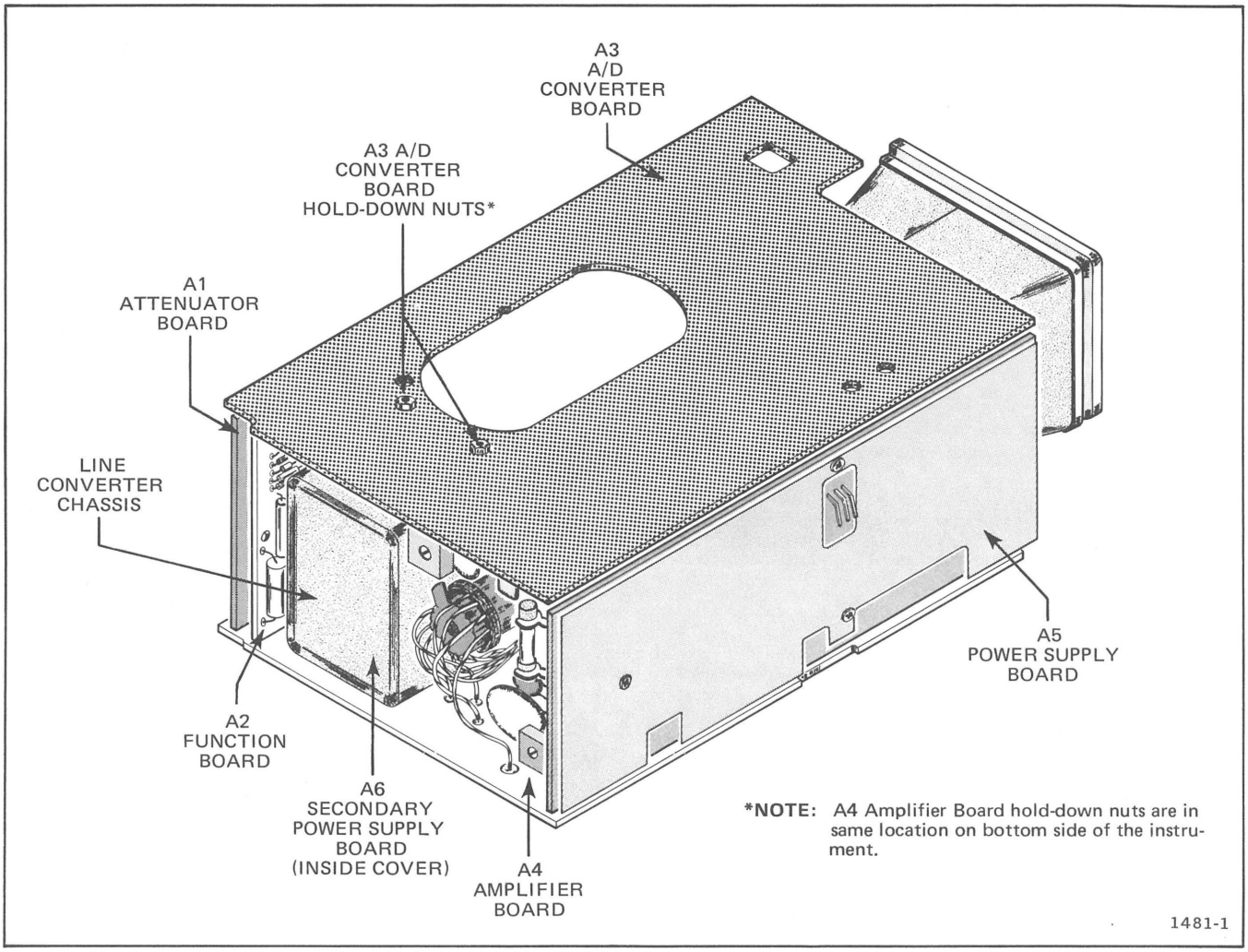



**Figure 4-2. Circuit board locator.**

The location of parts that are called out in the replacement procedures are found either on the Exploded View drawing in the Mechanical Parts List section or on accompanying disassembly figures.

**WARNING**

*Potentially dangerous high voltages exist inside this instrument when it is operating. Disconnect the instrument from the power line and* **turn it off** *(disconnecting the instrument from the power line* **does not** *turn it off) before removing the cabinet halves.*

**NOTE**

*In steps involving removal of circuit boards, extreme care is necessary to prevent the bending or breaking of terminal pins. Boards must be removed vertically in the same plane as they are set in the instrument. Do not twist or move boards in a shearing direction (left, right, away from, or toward viewer).*

**TOOLS REQUIRED.** The following tools are required for component removal and replacement:

Screwdriver, Phillips, 3", #1 point

Screwdriver, 4", 3/16" blade

Nutdriver (or socket), 3/16"

Pliers, longnose

Soldering Iron, 15 watt

Soldering Iron, 35-40 watt

Integrated Circuit Extractor[1] (Tektronix Part No. 003-0619-00)

Kit, Circuit Board Pin[1] (Tektronix Part No. 040-0542-00)

Desolder Tool[1] (Tektronix Part No. 003-0652-00)

Solder Wick[1] (Tektronix Part No. 006-1356-00)

**CABINET REMOVAL.** Removal of the cabinet is required to replace the power line fuse or the mA input protection fuse, and to perform calibration or troubleshooting. Proceed as follows:

1. Unwind the probe lead and then the power cord. Turn the instrument upside down on its top and remove the four screws holding the cabinet together (see Figure 4-3). Two of the screws are located inside the probe storage slot.

**NOTE**

*The instrument is not secured to either cabinet half except by a tight fit around the crt face plate; therefore, if the instrument remains attached to*

[1] **Optional tools.**

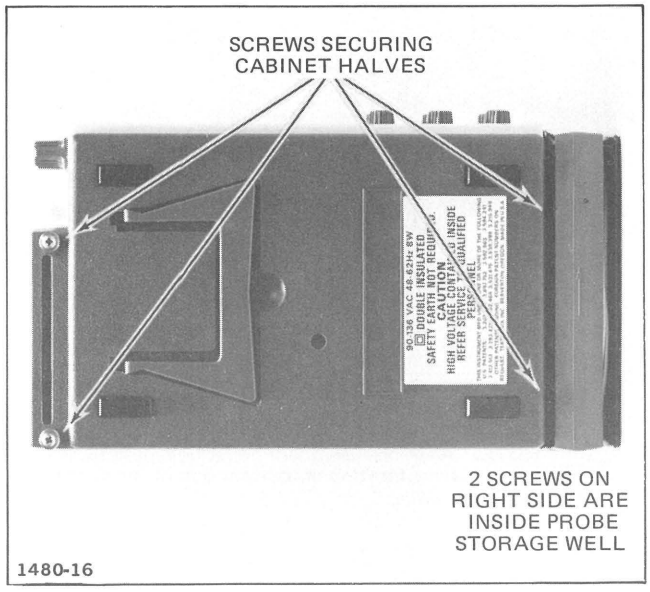



Figure 4-3. Location of screw securing cabinet halves.

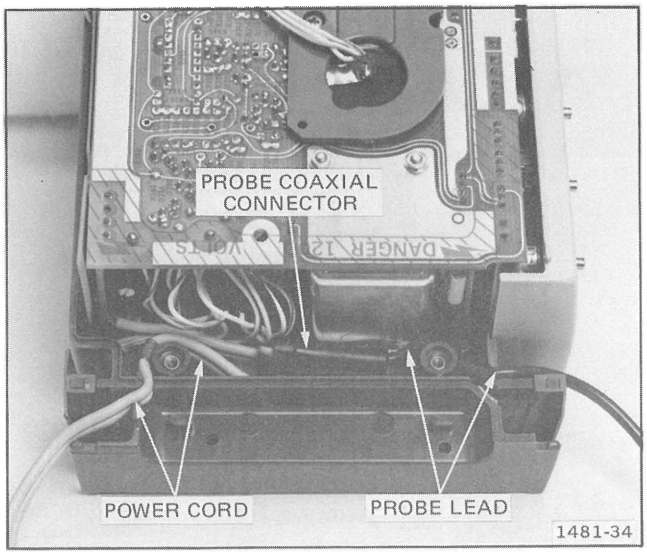



Figure 4-4. Power cord and probe lead routing.

*either cabinet half as it is liften off, it can drop free and be damaged.*

2. Remove the bottom cabinet half and note the position and routing of the power cord and probe lead (see Figure 4-4) and the PWR (BTRY) LED led (see Figure 4-9). Lift the instrument out of the top cabinet half and set the cabinet halves aside. Be sure the rear panel insulated compartment cover and the cabinet screws have not fallen free to become lost.

**CABINET REPLACEMENT.** Replace the cabinet halves in the reverse order of Removal. When setting the instrument into the top half and when installing the bottom half, be sure the instrument settles onto the plastic guide posts so the cabinet fits together completely without being forced. After setting the instrument into the top half, be sure the power line cord and probe lead are properly routed and placed in their respective cabinet exit slots before installing the bottom half (see Figure 4-4). Install the rear-panel compartment cover and securing screws. A suggested method for installing the rear panel cover is to install and lightly tighten the screws, then insert the cover hinge into its respective holes and tighten all the screws.

**BATTERY REMOVAL.** To remove the batteries, remove the cabinet, (see Cabinet Removal), set the instrument on its top, disconnect the battery lead, and remove the battery retainer hold-down screw. Remove the battery retainer and batteries, then tilt the instrument up on its side and remove the other battery retainer.

**CAUTION**

*Do not set the batteries on a metal surface as the bottoms are at a one cell potential difference and one of the cells will be shorted and destroyed. Also, the cell tab connected to pins 1 and 3 of P444 may be long enough to touch the other tab on the cell which will short out the cell and destroy it. To prevent this problem, the negative tab of this cell is folded over ¼ inch and soldered before leaving the factory. It is recommended this same procedure be followed if other than a direct replacement battery pack is used.*

**BATTERY REPLACEMENT.** Replace the battery in the reverse order of Removal. Be careful not to overtighten the battery retainer hold-down screw.

**A/D CONVERTER BOARD REMOVAL.** To remove the A/D Converter Board, remove the cabinet and batteries (see Cabinet Removal and Battery Removal), then proceed as follows:

1. Turn the instrument over on its bottom and remove the two nuts holding the A/D Converter Board to the Line Converter Chassis (see Figure 4-2).

2. Gently remove the A/D Converter Board by lifting it up and free of the terminal pins. Remove the electrical contact (see Figure 4-7) and set it aside for reinstallation.

**A/D CONVERTER BOARD REPLACEMENT.** Replace the A/D Converter Board in the reverse order of Removal. Be sure the electrical contact is properly installed (see Figure 4-7). Be careful not to bend the terminal pins on reinsertion of the board. Also, make sure all the pins enter their respective terminal pin sockets.

**CRT REMOVAL.** To remove the crt assembly (crt and shield) complete the Removal steps of all preceding components, then proceed as follows:

1. Disconnect the crt base socket and the three-terminal connector holder just below and to the left of the crt base socket.

2. Gently pull the crt assembly toward the front of the instrument and out of the crt retainer ring. If the assembly is very tight in the ring, gently rock it back and forth while pulling it out. Do not rotate the assembly in the retainer ring over about 1/8 inch as there is a solder spot on the crt shield which is located within the retainer ring slot. Rotating the assembly beyond these limits may loosen the solder connection or damage the crt retainer ring.

**Disassembly.** To disassemble the crt assembly, proceed as follows:

**WARNING**

*Use care when handling a crt. Protective clothing and safety glasses should be worn. Avoid striking it with any object which might cause it to crack or implode. When storing a crt, place it in a protective carton or set it flat on a smooth surface with a soft mat under the faceplate edge.*

1. Remove the shield-lead terminal connector from the three-connector terminal connector holder by bending the top part of the holder away from the connector and removing the connector from the holder (see Figure 4-10).

2. Gently pull the crt completely out of the crt shield. Remove the crt support ring and lay it aside for reassembly.

NOTE

*New crt's are supplied with the trace rotation coil already installed. If the trace rotation coil is faulty, contact the nearest Tektronix Field Office or representative for assistance.*

**Reassembly.** To reassemble the crt assembly, proceed as follows:

1. Insert the crt into the shield with the trace rotation coil leads on the opposite side from the shield seam. Insert the crt support ring from the crt socket end of the shield, and carefully push it down inside the shield with a small blunt instrument until it is about 1/8 inch beyond the soldered lead on the shield.

2. Reinsert the shield lead terminal connector into the plastic holder.

**CRT REPLACEMENT.** Replace the crt assembly in the reverse order of Removal. Insure that the seam on the crt shield is facing toward the top of the instrument.

**POWER SUPPLY BOARD REMOVAL.** To remove the Power Supply Board, perform the Removal steps of all preceding components, except the crt, then proceed as follows:

1. Disconnect the terminal connector holders that are connected to the Power Supply circuit board from the Secondary Power Supply and the PWR (BTRY) LED.

NOTE

*Take care in removing this board, as there is another terminal connector holder on the instrument side of the bottom of the board which is disconnected after the board is removed.*

2. Gently lift the board up and **just free** of the Amplifier Board, then tilt the top away from the instrument and disconnect the terminal connector holder that is on the cable from the crt base socket.

**Disassembly.** Further disassembly involves removing the shields for troubleshooting, repair, or replacement of parts. Proceed as follows (see Figure 4-5):

**WARNING**

*If this board is to be reinstalled in the instrument for troubleshooting, removal of the shields exposes a shock hazard on the board. Also, if the terminal connector holder from the Secondary Power Supply Board (P420) is not connected to the Power Board and the instrument power plug is connected to and then disconnected from the power line, the two large capacitors (C417 and C418) under the shield on the parts side of the board do not discharge which could create a possible shock hazard.*

1. Being careful not to lose the small spacers under the laminate shield (on soldered side of board), remove the three screws from the laminate shield and remove the shields on both sides of the board.

2. The metallic shield can be further disassembled by removing the three screws holding the two plastic posts and one metal post (note that the metal post is installed on the board adjacent to the thick film resistor). The mylar insulator attached to the metal shield is held in place with a piece of double-stick tape.

**Reassembly.** Reassemble the shields in the reverse order of Disassembly. If difficulty is encountered in keeping the ring spacers in place under the laminate shield during reassembly, two suggested methods for reassembly are as follows:

1. For the first method, set the metal shield with the mylar insulator in place on the board and place these on a flat surface with the board on top. Place a ring spacer on the board hole nearest the power line cord, insert a screw through the corresponding hole in the laminate shield, set the shield in place, and just tighten the screw until the threads catch hold. Gently lift the laminate shield and place a ring spacer over the board hole near the ASTIG adjustment hole. Then insert a screw and again just tighten it until the threads catch hold. Slide the last ring spacer in place over the hole near the battery terminal pins, insert a screw, and then tighten all the screws.

2. For the second method, install the screws in the laminate shield and set it on a flat surface with the writing side of the shield down. Install the ring spacers and set the board in place on top of the spacers. Remove the posts from the metal shield and install them on the laminate shield screws. Then install the metal shield with its mylar insulator, and install and tighten its attaching screws.

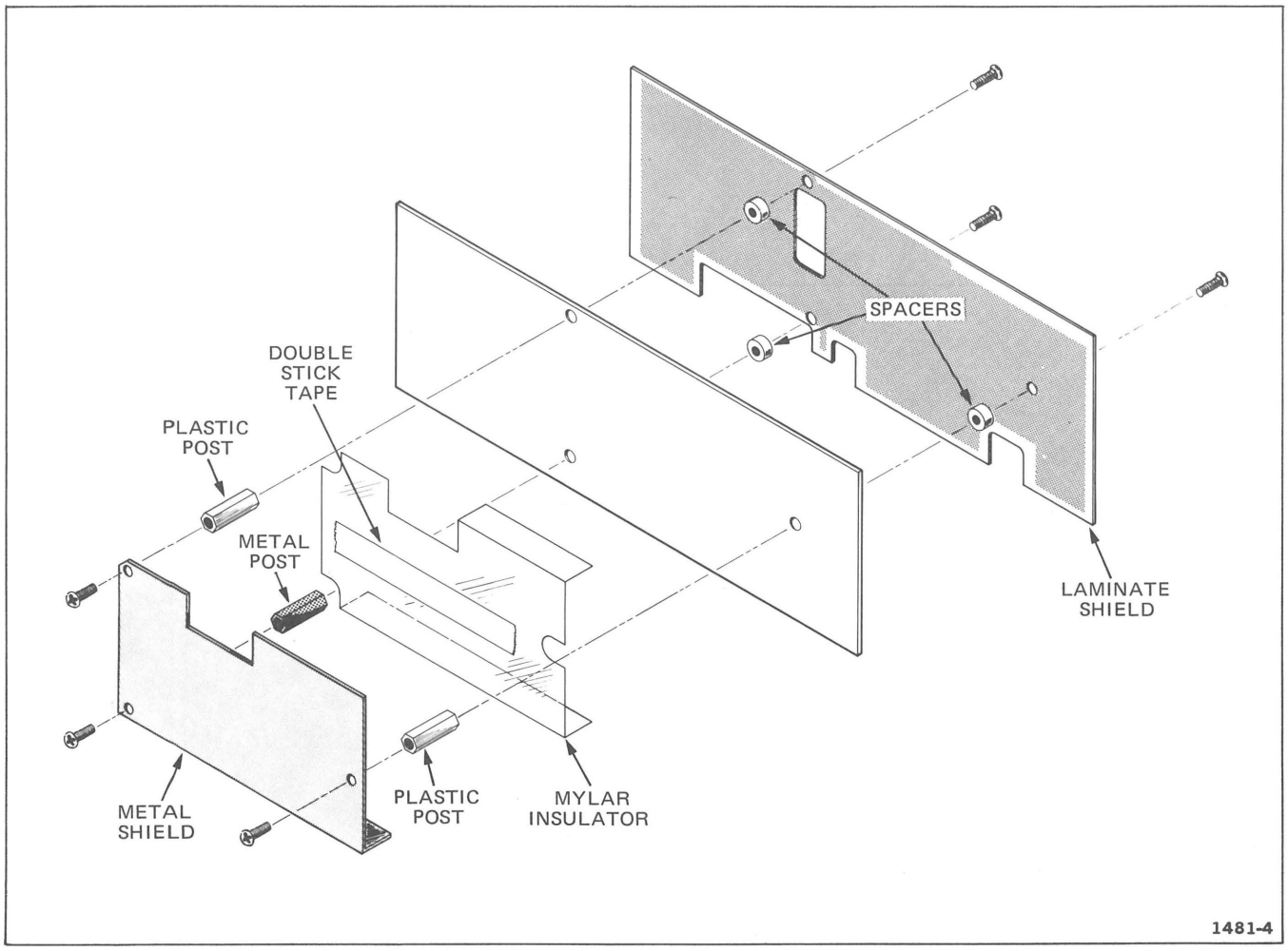



**Figure 4-5. Power Supply Board disassembly.**

**POWER SUPPLY BOARD REPLACEMENT.** Replace the Power Supply Board in the reverse order of Removal. Insure that the two-connector terminal connector holder from the crt base socket has been plugged into the board before installing the crt base socket.

**SIDE PANEL REMOVAL.** To remove the side panel, perform the Removal steps for the cabinet, batteries, and A/D Converter Board, then proceed as follows:

1. Disconnect the LED terminal connector holder from the Power Supply Board (see Figure 4-9), then remove the side panel assembly (side panel with Attenuator and Function Boards) by lifting it up and free of the Amplifier Board terminal pins.

2. Remove all knobs from the front panel and side panel (retained only by a tight fit). Depress all pushbuttons so they remain in a depressed condition (the VOLTS, mA, and Ω pushbuttons will have to be pushed simultaneously to lock them in the depressed position).

3. Remove the two side panel attaching screws located on the Function Board side of the assembly (see Figure 4-6). Remove the board assembly (Attenuator and Function Boards) from the side panel by simultaneously raising the rear of the board assembly (end opposite the pushbuttons) and pulling it toward the rear.

**NOTE**

*The slide switch covers, which form a part of the operator safety protection, may drop free of the Attenuator Board at this time. These covers, as well as the potentiometer insulator bushings should be removed to prevent loss.*

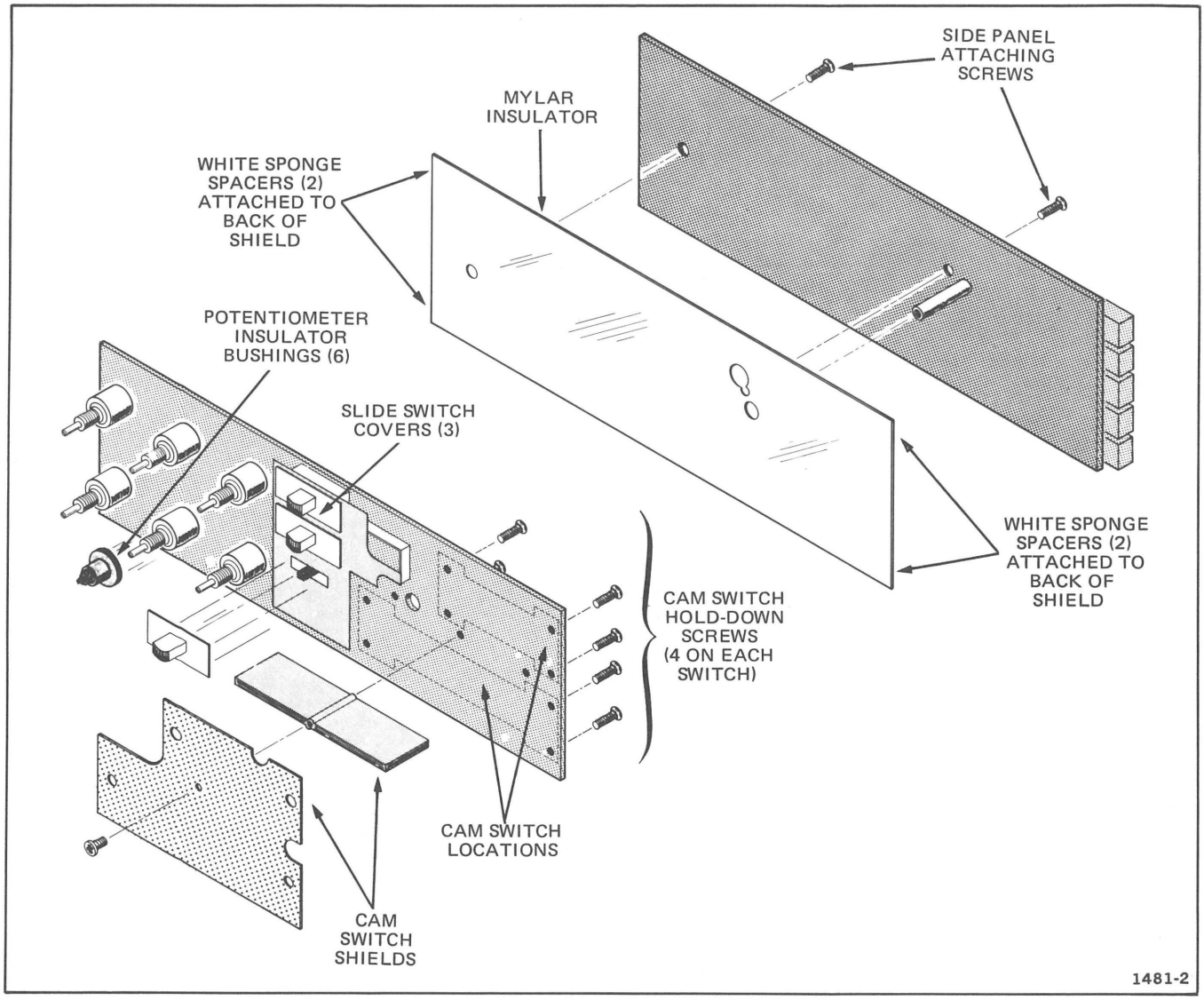



**Figure 4-6. Attenuator and Function Board disassembly.**

4. Remove the PWR (BTRY) LED assembly by gently pulling it out of its side-panel hole (see the Exploded View drawing in the Mechanical Parts List section).

**SIDE PANEL REPLACEMENT.** Replace the side panel in the reverse order of removal. The pushbutton switch knobs can be removed by pulling them off, which will make installation of the side panel easier. Be sure that the slide switch covers and potentiometer insulator bushings are installed before installing the board assembly into the side panel. Also, insure that the LED is installed in the side panel and its lead is properly placed in the Attenuator Board cam switch shield cut-out.

**ATTENUATOR BOARD REMOVAL.** To remove the Attenuator Board, perform the Removal steps for the side panel, then proceed as follows (see Figure 4-6):

1. Gently pull the Attenuator and Function Boards straight apart (retained only by the tight fit of the terminal pins).

2. Remove the mylar insulating strip (be careful not to lose the small white sponge spacers).

**Disassembly.** At this point, disassembly instructions are limited to removal of the cam switch shields, which is done by removing their respective hold-down screws. Cam switch disassembly is covered under Parts Replacement.

**Reassembly.** Reassemble the Attenuator Board in the reverse order of Disassembly.

**ATTENUATOR BOARD REPLACEMENT.** Replace the Attenuator Board in the reverse order of Removal.

**FUNCTION BOARD REMOVAL.** Removal of the Function Board is identical to removal of the Attenuator Board.

**Disassembly.** No further disassembly is covered here. Disassembly of the pushbutton switches is covered under Parts Replacement.

**Reassembly.** Reassemble the Function Board in the reverse order of Disassembly.

**FUNCTION BOARD REPLACEMENT.** Replace the Function Board in the reverse order of Removal.

**SECONDARY POWER SUPPLY REMOVAL.** To remove the Secondary Power Supply, perform the Removal steps for the cabinet, batteries, A/D Converter Board, and crt. Then proceed as follows (see Figure 4-7):

1. Disconnect the terminal connector holder between the Secondary Power Supply Board and the Power Supply Board.

2. Turn the instrument on its side and remove the two nuts holding the Line Converter Chassis to the Amplifier Board (see Figure 4-2).

3. Gently lift the Line Converter Chassis out of the instrument. Remove the electrical contacts and set them aside for reinstallation.

**Disassembly.** At this point, disassembly instructions are limited to mechanical disassembly. Proceed as follows (see Figure 4-7):

**NOTE**

*Operator safety is dependent upon the electrical separation between the power line and instrument common, which is dependent upon the proper installation of parts and the spacing between them. Therefore, disassembly of the Secondary Power Supply is not recommended unless a trouble has been definitely isolated to that particular component.*

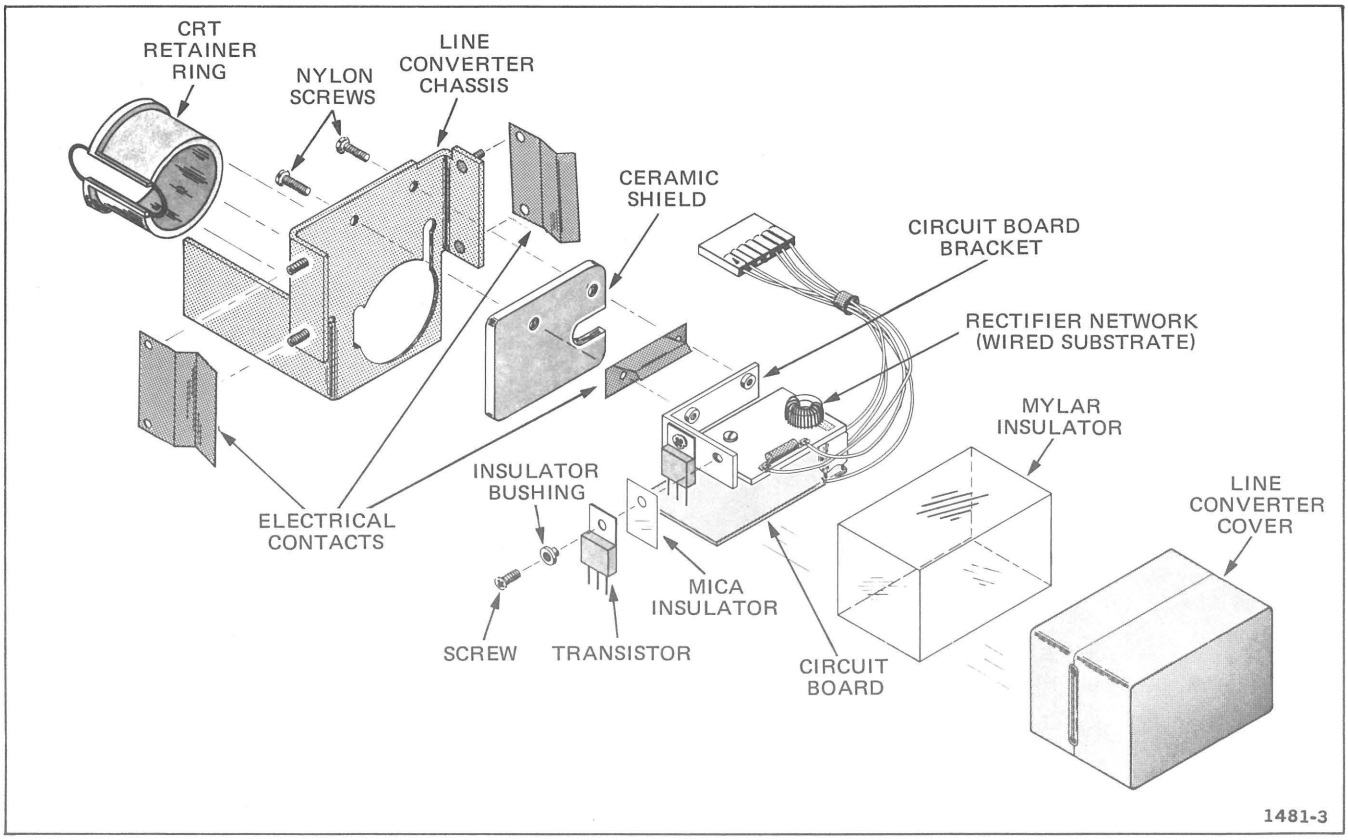



Figure 4-7. Secondary Power Supply disassembly.

1. Remove the crt retainer ring by gently squeezing it together and pushing it out of its hole in the line converter chassis. Remove the line converter cover by pulling it away from the chassis. Remove the mylar insulator from inside the cover, as it is reinstalled separately during reassembly.

2. Remove the two plastic screws holding the circuit board bracket to the line converter chassis. Remove the line converter chassis by sliding the secondary power supply cable with its grommet, toward the crt support ring hole and pulling the cable and plug through the hole. Then separate the ceramic shield, electrical contact and circuit board bracket. Be careful that the ceramic shield does not fall free as it may crack or break.

**WARNING**

*Some of the disassembled parts in the Secondary Power Supply are coated with silicone grease which can cause eye irritation; therefore, handle these parts with care and avoid getting the grease in the eyes. Wash hands thoroughly after completing work involving contact with silicone grease.*

3. Remove the two screws holding the transistor tabs to the circuit board bracket. Be careful not to lose the small mica insulation strip under one of the transistor tabs and the insulator bushing on the screw for that same transistor.

4. Remove the screw and nut holding the circuit board and the wired substrate together by holding the nut and gently turning the screw. Be careful not to apply too much pressure to the substrate as it may crack. Gently slide the circuit board bracket from between the substrate and circuit board, then separate these parts by carefully pulling them straight apart.

**NOTE**

*Repair of the Rectifier Network (wired substrate) is not recommended. If faulty, replace as a unit.*

**Reassembly.** Reassemble the Secondary Power Supply in the reverse order of the Disassembly. Apply the following precautions:

1. For step 4. If the converter transformer (T430) or substrate has been replaced, or the bracket cleaned, coat both sides of the bracket tab with a thin film of silicone grease before reassembly. Also, only lightly tighten the screw holding the substrate and circuit board together so they will self-align when the bracket is attached to the chassis in step 2, and when the cover is installed in step 1.

2. For step 3. Insure that the mica insulating strip and insulating washer is installed properly and on the correct transistor. If the transistors or the mica strip have been replaced, or the bracket cleaned, coat the transistor tabs, mica insulator, and the bracket with a thin film of silicone grease before assembly.

3. For step 2. If either the circuit board bracket, electrical contact, ceramic shield, or line converter chassis have been cleaned or replaced, coat the mating surfaces of the cleaned or replaced parts with a thin film of silicone grease before reassembly. Be sure all the parts are installed properly. Only lightly tighten the two plastic screws so the assembled unit will self-align when the cover is installed in step 1.

4. For step 1. Install the mylar cover insulator and be sure the electrical contact is outside the mylar so it will make contact with the inside of the cover. Install the cover tightly against the line converter chassis and tighten the two plastic screws. Do not overtighten these screws as the threads will strip easily. Insert the crt support ring from the chassis side opposite the supply components.

**SECONDARY POWER SUPPLY REPLACEMENT.** Replace the Secondary Power Supply in the reverse order of Removal. Be sure that the electrical contacts are properly installed between the supply and the Amplifier and A/D Converter Boards.

**AMPLIFIER BOARD REMOVAL.** To remove the Amplifier Board, perform the Removal steps for the cabinet and batteries, then proceed as follows:

1. Set the instrument on its bottom and unplug the crt base socket and the crt terminal connector holder just below and to the left of the crt base socket.

2. Turn the instrument on its top and remove the two Amplifier Board hold-down nuts (see Figure 4-2).

**NOTE**

*Be careful when removing the Amplifier Board as there is another terminal connector holder to be removed after the board is free of the terminal pins.*

3. Carefully lift the board straight up and just free of the terminal pins, then tilt slightly and remove the remaining terminal connector holder on the cable from the Power Supply Board. Remove the electrical contact from the line converter chassis (see Figure 4-7) and set it aside for reinstallation.

**AMPLIFIER BOARD REPLACEMENT.** Replace the Amplifier Board in the reverse order of Removal. Be sure the electrical contact is properly installed (see Figure 4-7). Be careful not to bend the terminal pins upon reinsertion of the board. Also, make sure that all the pins enter their respective terminal pin sockets.

**SEMICONDUCTOR REPLACEMENT.** Semiconductors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the calibration of this instrument. When semiconductors are replaced, check the operation of the part of the instrument which may be affected.

Replacement semiconductors should be of the original type or a direct replacement. Lead configuration of the semiconductors used in this instrument are shown in the Diagrams section. Some plastic case transistors may have lead configurations which do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing as used for metal-cased transistors. Transistors which have heat radiators or are mounted on the chassis use silicone grease to increase heat transfer. Replace the silicone grease when replacing these transistors.

**WARNING**

*Silicone grease can cause eye irritation; therefore handle it with care and avoid getting in the eyes. Wash hands thoroughly after use.*

An extracting tool should be used to remove the integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. as Tektronix Part No. 003-0619-00. If an extracting tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other which may damage the pins.

**FUSE REPLACEMENT.** This instrument contains two fuses, a power line fuse and a current (mA) input protection fuse.

Replacement of the power line fuse requires removal of both cabinet halves (removal of the top half for fuse replacement necessitates removal of the bottom half for proper placement of the power cord and probe lead during reassembly).

Replacement of the current (mA) fuse requires removal of the bottom cabinet half only.

Refer to the Cabinet Replacement instructions for cabinet removal, and to Figures 4-8 and 4-9 for fuse locations.

**PROBE REPLACEMENT.** The complete probe assembly can be replaced as one unit by simply pulling the coaxial-type end lead connectors apart (see Figure 4-4) after removing the bottom cabinet half.

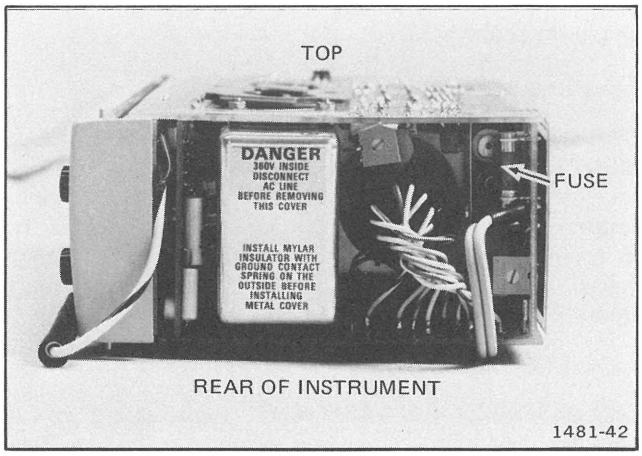



**Fig. 4-8. Power-line fuse location.**

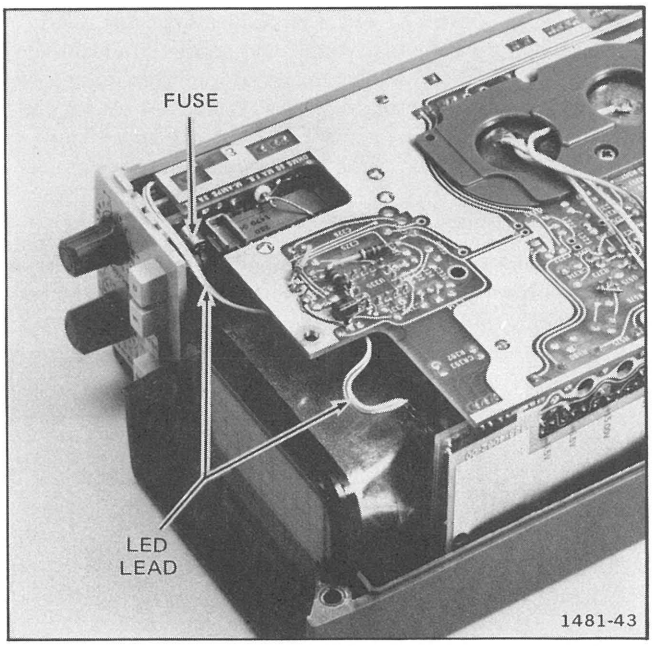



**Fig. 4-9. Current (mA) input fuse location.**

**Disassembly.** The probe can be disassembled by referring to the Exploded View drawing in the Mechanical Parts List section and the following disassembly instructions:

1. The test prod tip is retained by a tight fit only, and is removed and reinstalled by pulling it off or pushing it on the probe body assembly.

2. The probe body assembly is removed by pulling it out of the cable assembly probe head, and reinstalled by pushing it onto the same probe head.

3. The common clip lead is removed from and reinstalled on the probe head by pulling it out of or pushing it into the slot in the probe head.

**COAXIAL-TYPE END LEAD CONNECTOR REPLACEMENT.** Replacement of the coaxialtype end lead connector, such as used on the probe lead and its corresponding instrument lead, requires special tools and techniques. It is recommended that the complete lead assembly be replaced, or that replacement be referred to the local Tektronix Field Office or representative.

**LED ASSEMBLY REPLACEMENT.** Replacement instructions for the LED Assembly are included in the Side Panel Removal and Replacement instructions.

**INTERCONNECTING CABLE AND TERMINAL CONNECTOR REPLACEMENT.** The interconnecting cable assemblies are factory assembled items, and consist of machine installed end-lead connectors mounted in plastic holders to make up multi-connector plugs. The plastic holders are easily replaced as individual items, but if the cables are faulty, it is recommended that these be replaced as a complete assembly.

It is possible for the end-lead terminal connectors to become dislodged from the plastic holders. If this happens, the connector can be reinstalled as follows (see Figure 4-10):

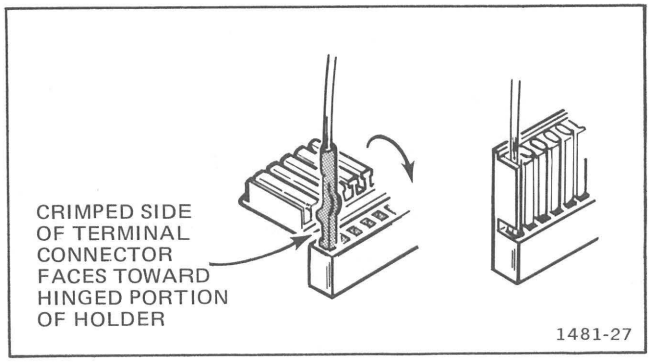



**Fig. 4-10. Terminal connector holder.**

1. Bend the grooved portion of the holder (part nearest the cable) away from the cable in the direction of its hinged side.

2. Reinsert the connector into its proper hole in the plug-in portion of the holder (see color coding comment in next paragraph) and bend the grooved part of the holder so the connector is inserted into the groove.

The plastic holder has each connector hole numbered, except number one which is identified with an triangle or dot. Except for the crt three-terminal connector holder, each cable or wire connected to each connector is EIA color coded (see Troubleshooting Aids) to match each connector hole number (e.g., the arrow head which is pin number 1 is brown striped, pin 2 is red striped, pin 6 is blue striped, etc).

**CIRCUIT BOARD TERMINAL PIN AND TERMINAL PIN SOCKET REPLACEMENT.** A circuit board terminal pin replacement kit including the necessary tools, instructions, and replacement pins is available from Tektronix, Inc. or through the local Tektronix Field Representative (Tektronix Part No. 040-0542-00).

**Terminal Pin.** To replace a terminal pin, proceed as follows:

**CAUTION**

*It is essential that extreme care be used with the soldering iron when removing or installing the terminal pins in the circuit board. Board delamination can easily occur which is difficult or impossible to repair, especially in the case of multi-layer circuit boards as used in this instrument.*

1. While using a 15 watt soldering iron to unsolder the pin, use a pair of pliers to pull the pin out of its ferrule which should remain in the circuit board. If the pin is too short to use the pliers, it can be pushed out with any round device not over 0.028 inch in diameter.

2. Use a 0.031 inch drill to carefully ream out the inside of the old ferrule that remained in the circuit board.

3. Remove the ferrule from the new pin, then insert and position the new terminal pin in the ferrule that was left in the circuit board. When the pin is properly positioned, carefully solder it on both sides of the circuit board.

**Terminal Pin Socket.** To replace terminal pin sockets, proceed as follows:

1. Unsolder the tabs holding the terminal pin socket to the board (located on the opposite side of the board from the socket). Use a vacuum-type desoldering tool or solder-wick to remove the solder. Straighten the socket tabs and remove the socket.

2. Install the new socket into the circuit board tab holes and bend the tabs against the circuit board. Solder the tabs on both sides of the circuit board. Be careful not to get solder inside the socket.

**CAM SWITCH REMOVAL.** To remove a cam switch, perform the Removal and Disassembly steps for the Attenuator Board, then remove the screws holding the cam switch to the board. These screws are located on the opposite side of the board from the switch.

**CAM SWITCH REPLACEMENT.** Before replacing a cam switch, refer to preventive maintenance lubrication instructions for the cam switches. Replace the cam switch in the reverse order of Removal and Disassembly. Be sure that the flush end of the mounting bearings are facing toward the rear of the board when installed.

**CAM SWITCH CONTACT REPLACEMENT.** Replacement of the cam switch contacts requires special alignment and spacing tools. For assistance in replacement or repair of cam switch contacts, contact your local Tektronix Field Office or representative.

**NOTE**

*As special repair kits become available to the Tektronix, Inc. Field Service centers and the Factory Service Center, these are available also to the user. For the latest information on kit availability, contact your local Tektronix Field Office or representative.*

**SLIDE SWITCH REMOVAL.** The POWER and TRIGGER selection slide switches are the routinely replaced solder-in type. The INPUT COUPLING slide switch is a special Tektronix designed device which may be repaired by cleaning or parts replacement. The following instructions apply only to this switch.

To remove the special slide switch, perform the Removal steps for the Attenuator Board and proceed as follows:

1. Unsolder the four soldered hold-down points of the slide switch shield and remove the shield.

**NOTE**

*At this point, the switch can be removed or disassembled for inspection, cleaning, or parts replacement. Complete removal is explained first.*

2. Carefully remove the two nuts and spacers from the plastic posts on the opposite side of the board. Remove the switch by pulling it away from the board being careful not to lose the small switch contacts under the switch.

**Disassembly.** The switch is further disassembled by gently prying one of the ends away from the slider cover and removing the cover and slider.

**NOTE**

*If the switch was intermittent, but an inspection does not reveal a fault, clean the board contacts with a typewriter type eraser, remove the eraser debris, reassemble the switch, and recheck it.*

**Reassembly.** Reassemble the slide switch in the reverse order of Disassembly. Be careful that the switch contacts do not become misaligned during reassembly.

**SLIDE SWITCH REPLACEMENT.** Replace the slide switch in reverse order of Removal. Do not overtighten the nuts on the plastic switch posts.

**PUSHBUTTON SWITCH REPLACEMENT.** Replacement of the complete pushbutton assembly requires special alignment and spacing tools. For assistance in repair or replacement, contact your local Tektronix Field Office or representative.

## TROUBLESHOOTING

The following information is provided to facilitate troubleshooting of the 213. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles, particularly where integrated circuits are used.

### Troubleshooting Equipment

The majority of troubleshooting to be done on the 213 can be accomplished with two extender cards, a digital multimeter, a function generator, a general purpose oscilloscope, and a line isolation transformer. If transistor and linear integrated circuits are to be tested rather than substituted, a curve tracer would be required. The extender cards are the A/D Extender Card (Tektronix Part No. 067-0759-00) and the Power Supply Extender Card (Tektronix Part No. 067-0758-00). To obtain these cards, contact your local Tektronix Field Office or representative. Extender card

installation instructions are contained in the Troubleshooting Aids portion of this section. Suggested types of test equipment useful for troubleshooting are as follows:

**Digital Multimeter**

1. Tektronix 213 DMM Oscilloscope (cannot be used for the high-voltage multiplier). Use an ordinary multimeter to measure the multiplier (e.g. Triplette Model 630-NA).

2. Tektronix DM 501 (requires TM 500-series Power Module. See Calibration section Equipment Required list.)

**Function Generator**

Tektronix FG 501 (requires TM 500-series Power Module. See Calibration section Equipment Required list.)

**General Purpose Oscilloscope**

Tektronix 213 DMM Oscilloscope. (Refer to the Tektronix Products catalog for other oscilloscope systems with characteristics similar to the 213.)

**Curve Tracer**

Tektronix 577 with a 177 Standard Test Fixture and a 178 Linear IC Test Fixture.

**Line Isolation Transformer**

Allied Part No. 928-3010.

## Troubleshooting Aids

**A/D EXTENDER CARD.** To install the A/D Extender Card, perform the A/D Converter Board Removal steps, then refer to Figure 4-11 and proceed as follows:

1. Insert the A/D Converter Board into the A/D Extender Card from the side, then vertically insert the extender card into the Function Board.

2. Connect the extender card cables (2) between the A/D Converter Board terminal pins and their matching terminal pin sockets on the Power Supply Board.

To remove the extender card, reverse the installation procedure.

**POWER SUPPLY EXTENDER CARD.** To install the Power Supply Extender Card, perform the Power-Supply Board steps, then refer to Figure 4-11 and proceed as follows:

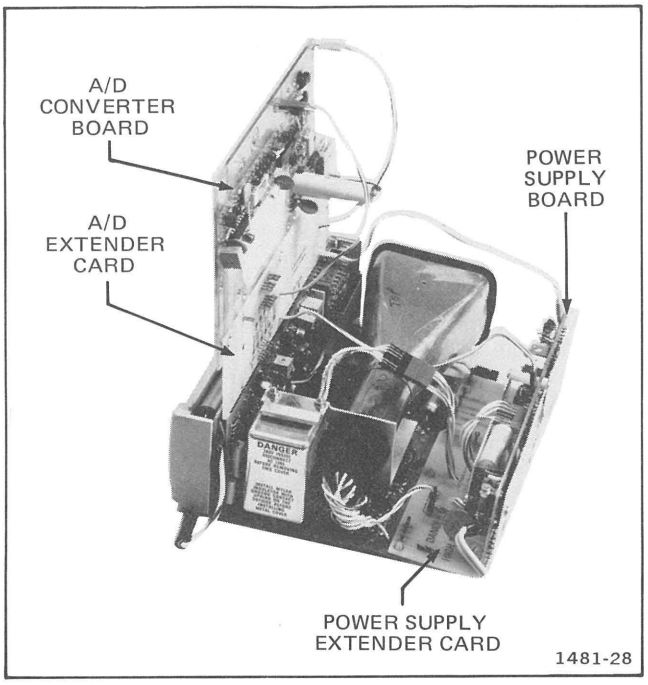



**Fig. 4-11. Installation of extender cards.**

1. With the terminal pins and terminal sockets of the card sockets of the card facing upward, insert the card onto the Amplifier Board. Then vertically insert the Power Supply Board onto the card.

2. Connect the two-connector crt terminal connector holder to the extender card, and the extender card two-connector terminal connector holder to the Power Supply Board where the crt terminal connector would normally have been connected. Connect the five-connector terminal connector holder (terminal pins) cable assembly on the extender card between the corresponding connections on the Secondary Power Supply and Power Supply Boards.

**NOTE**

*At this point the A/D Converter Board may or may not be reinstalled with the A/D Extender Card. If only the oscilloscope functions of the instrument are to be tested, the A/D Converter Board does not need to be reinstalled; however, if it is not reinstalled, the instrument cannot be turned on unless a jumper is installed between the Power Supply Board terminal connector sockets 18 and 19.*

**WARNING**

*When Power Supply Board terminal connector sockets 18 and 19 are jumpered, the instrument cannot be turned off with the POWER switch. If components or parts are to be replaced, the batteries and the power line plug should be disconnected.*

**DIAGRAMS.** Complete circuit diagrams are on the foldout pages in the Diagrams section at the rear of this manual. The circuit number and electrical value of each part is shown on the diagrams (see the first page of the Diagrams section for the definition of the reference designators used to identify parts). Important voltages and waveforms are shown on the diagrams. The portions of the circuits mounted on circuit boards are enclosed with blue lines.

**CIRCUIT BOARDS.** Figure 4-2 shows the location of the circuit boards within the instrument along with their assembly (A) numbers. The assembly numbers are also used on the diagrams to aid in locating the boards. To aid in cross-referencing between the diagrams and the circuit board, circuit board layouts are shown in the Diagrams section opposite the circuit diagram. Each electrical component on the boards is identified by its circuit number and listed in the table near the circuit board layouts. To find a component, locate it in the component list and note the coordinates listed with it. Then locate the coordinates on the layout and the component is located within this area.

**SEMICONDUCTOR LEAD CONFIGURATION.** Figure 9-1 shows the lead configurations of the semiconductors used in this instrument. The cathode end of most diodes used in this instrument are indicated by a stripe, a series of stripes, or a dot.

**COMPONENT AND WIRING COLOR CODE.** Colored strips or dots on resistors and capacitors signify electrical values, tolerances, etc., according to EIA standard color code. Components not color-coded usually have the value printed on the body.

Except for the crt three-connector terminal connector holder, terminal connector holder wiring is also color-coded to each numbered connector according to the EIA color code (e.g., pin 2 has a red striped wire, pin 3 an orange striped wire, pin 6 a blue striped wire, etc.).

The EIA color code as used for some parts is shown in Figure 4-12.

## Troubleshooting Procedure

The following troubleshooting procedure is arranged to check the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks insure proper connection, operation, and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component or part.

**1. Check Control Settings.** Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, refer to the Operating Instructions section.

**2. Check Associated Equipment.** Before proceeding with troubleshooting check that the signal is properly connected and that the interconnecting cables are not defective.

**3. Visual Check.** Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, and interconnecting pins not inserted into their respective sockets.

NOTE

*The spring tension of the pin sockets ensures a good connection between the circuit board and the pin. This spring tension can be destroyed by using the pin sockets as a connecting point for spring-loaded probe tips, alligator clips, etc.*

**4. Check Instrument Performance.** Check the operation of the unit, or the affected circuit by performing the Performance Check procedure of Section 5. The apparent trouble may only be a result of misadjustment and may be corrected by calibration. Complete calibration instructions are given in Section 6.

NOTE

*At this point in the procedure it is recommended that the A/D Converter Board and Power Supply Board extender cards be installed (see Troubleshooting Aids for installation instructions).*

**5. Isolate Trouble to a Circuit.** To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. (e.g., poor focus indicates the crt circuit may be at fault).

Incorrect operation of all circuits often indicates trouble in the power supplies. Table 4-1 provides the operating tolerances for the power supplies in the 213.

Figure 9-24 provides a guide for locating a defective circuit, component, or part. When a defective circuit or component is identified, proceed with steps 6 and 7 to locate the defective part(s).

NOTE

*To better insure operator and equipment safety, it is recommended that all troubleshooting be done with the instrument operating on batteries, unless there is a problem in the battery charger.*

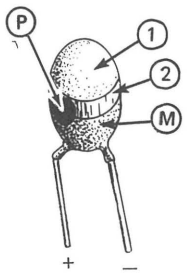
**TABLE 4-1**
**Power Supply Operating Tolerances**

| Power Supply | Test Point | Output Voltage Tolerance | Typical Ripple (Peak to Peak) |
|---|---|---|---|
| +6.5 V | TP550 | ±6.4 ± 0.3 V | 5 mV |
| −6.5 V | TP555 | ± 0.3 V | 5 mV |
| +15 V | TP545 | ± 0.15 V | 5 mV |
| +75 V | TP540 | ± 3 V | 0.1 V |
| −1000 V | TP530 | ± 10 V | Do not measure |

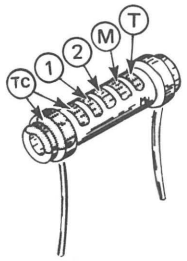
**NOTE (cont.)**

*Whenever the instrument is connected to the power line during internal troubleshooting, it should be connected through a line isolation transformer. This protects the operator from a possible shock hazard from the instrument floating power-line system, and protects the instrument from damage should the test instrument earth ground be connected to the 213 power line connection.*

DIPPED TANTALUM ELECTROLYTICS:




CERAMIC CAPACITORS:



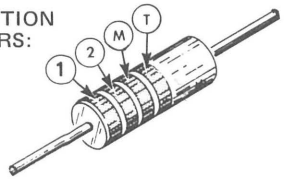

**RESISTOR AND CAPACITOR COLOR CODE**

| COLOR | FIGURES | MULTIPLIER | | TOLERANCE | | VOLTAGE RATING** |
|---|---|---|---|---|---|---|
| | | RESISTORS | CAPACITORS | RESISTORS | CAPACITORS | |
| SILVER | ——— | $10^2$ | ——— | ±10% | ——— | ——— |
| GOLD | ——— | $10^1$ | ——— | ±5% | ——— | ——— |
| BLACK | 0 | 1 | 1 | ——— | ±20% or 2 pF* | 4 VDC |
| BROWN | 1 | 10 | 10 | ±1% | ±1% or 0.1 pF* | 6 VDC |
| RED | 2 | $10^2$ | $10^2$ | ±2% | ±2% | 10 VDC |
| ORANGE | 3 | $10^3$ | $10^3$ | ±3% | ±3% | 15 VDC |
| YELLOW | 4 | $10^4$ | $10^4$ | ±4% | +100% −9% | 20 VDC |
| GREEN | 5 | $10^5$ | $10^5$ | ±0.5% | ±5% or 0.5 pF* | 25 VDC |
| BLUE | 6 | $10^6$ | $10^6$ | ——— | ——— | 35 VDC |
| VIOLET | 7 | ——— | ——— | ——— | ——— | 50 VDC |
| GRAY | 8 | ——— | $10^{-2}$ | ——— | +80% −20% or 0.25 pF* | ——— |
| WHITE | 9 | ——— | $10^{-1}$ | ——— | ±10% or 1 pF* | 3 VDC |
| (NONE) | ——— | ——— | ——— | ±20% | ±10% or 1 pF* | ——— |

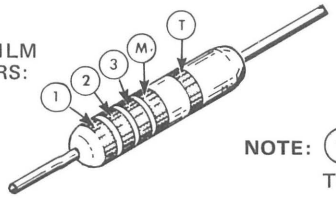
*FOR CAPACITANCE OF 10 pF OR LESS.

**FOR DIPPED TANTALUM CAPACITORS ONLY.

COMPOSITION RESISTORS:




METAL-FILM RESISTORS:




(1) (2) and (3) —1ST, 2ND, AND 3RD SIGNIFICANT FIGURES:

(M) —MULTIPLIER; (T) —TOLERANCE:

(TC) —TEMPERATURE COEFFICIENT;

(P) —POLARITY AND VOLTAGE RATING.

**NOTE:** (T) AND/OR (TC) COLOR CODE FOR CAPACITORS DEPENDS UPON MANUFACTURER AND CAPACITOR TYPE. MAY NOT BE PRESENT IN SOME CASES.

1481-44A

**Figure 4-12. EIA color code example.**

**6. Check Voltages and Waveforms.** Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Refer to the Diagrams section at the rear of the manual for correct voltages and waveforms.

**7. Check Individual Parts.** The following procedures describe methods of checking individual parts in the 213. Parts that are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

**a. Resistors.** Check the resistors with an ohmmeter. See the Electrical Parts List for the value and tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

**b. Inductors.** Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (roll off).

**c. Capacitors.** A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking if the capacitor passes ac signals.

**8. Repair and Readjust the Circuit.** If any defective parts are located, follow replacement procedures. Be sure to check the performance of any circuit that has been repaired or had any electrical components replaced.

## INSTRUMENT REPACKAGING

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to the following table for carton test strength requirements.
2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
4. Seal carton with shipping tape or industrial stapler.

### SHIPPING CARTON TEST STRENGTH

| Gross Weight (lb) | Carton Test Strength (lb) |
|---|---|
| 0-10 | 200 |
| 10-30 | 275 |
| 30-120 | 375 |
| 120-140 | 500 |
| 140-160 | 600 |

# PERFORMANCE CHECK

This section contains a procedure for checking instrument performance without removing the cabinet or making internal adjustments (external operators adjustments are made as needed). Only the performance essential to measurement accuracy and correct operation are checked. The procedure is also useful as an aid in troubleshooting and preventive maintenance. To aid in locating a step in the Performance Check procedure, an index is provided preceding the procedure.

## EQUIPMENT REQUIRED

The equipment required to accomplish the performance check procedure is listed in Table 6-1. The comments in the Equipment Required portion of Section 6 and the footnotes for Table 6-1 also apply to the performance check procedure.

## EQUIPMENT PREPARATION

Refer to Equipment Preparation in Section 6, except do not remove the equipment cabinet.

Control settings precede each major function to be performance checked. Titles for controls are fully capitalized in the procedure (e.g. INTENSITY).

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# A. DISPLAY

## Equipment Required

Screwdriver

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 1 (black scale) |
| SEC/DIV | 1 m |
| INPUT COUPLING | GND |
| TRIGGER | INTL AC AUTO |
| INTENSITY | Minimum for a visible display |
| LEVEL-SLOPE | Midrange of either slope (do not set at midrange of control) |
| VOLTS-mA/DIV VAR | CAL detent |
| HORIZ MGF VAR | CAL detent |

### 1. CHECK/ADJUST FOCUS

a. Set SEC/DIV to .5 (spot will slowly sweep across the screen.

b. CHECK—Spot is well defined.

c. ADJUST—FOCUS (side-panel screwdriver adjustment) for the best spot definition.

d. Reset SEC/DIV to 1 m.

### 2. CHECK/ADJUST TRACE ROTATION

a. Vertically position the trace on the center horizontal graticule line.

b. CHECK—Trace is parallel to the center horizontal graticule line.

c. ADJUST—TRACE ROTATE (side-panel screwdriver adjustment) to make trace parallel to the center horizontal graticule line.

# B. VERTICAL SYSTEM

## Equipment Required

1. Amplitude Calibrator
2. Sine-Wave Generator
3. Probe Adapter
4. Screwdriver
5. Low-Capacitance Screwdriver
6. Attenuator, 5X
7. Termination, Feedthrough
8. Adapter, Banana Plug

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button in |
| RMS | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 0.1 (blue scale) |
| INPUT COUPLING | GND |
| INTENSITY | Minimum for a visible display |

### 1. CHECK/ADJUST DC BALANCE

a. Alternately select the 0.1 V and 1 V range (blue scale) on the VOLTS-mA/DIV switch.

b. CHECK—Display has the same count (approximately zero) and polarity sign in both switch positions.

c. ADJUST—DC BAL (side-panel screwdriver adjustment) for the same count and polarity indication.

### 2. CHECK VERTICAL DEFLECTION ACCURACY

a. Set:

| | |
|---|---|
| DMM | Button out |
| INPUT COUPLING | DC |
| VOLTS-mA/DIV | 20 m (black scale) |
| SEC/DIV | 1 m |
| LEVEL-SLOPE | Midrange of either slope (do not set at midrange of the control) |

b. Connect the probe to the Amplitude Calibrator with a probe adapter. Set the Calibrator for an output of 1 kHz and adjust for a stable display.

c. Set VOLTS-mA/DIV and Calibrator as shown in Table 5-1.

d. CHECK—Vertical deflection accuracy is within limits shown in Table 5-1.

**TABLE 5-1**
**Vertical Deflection Accuracy**

| VOLTS-mA/DIV Setting (black scale) | Amplitude Calibrator Setting | Deflection (Divisions) | Limits (Divisions) |
|---|---|---|---|
| 10 m | 50 mV | 5 | 4.85 to 5.15 |
| .5 | 2 V | 4 | 3.88 to 4.12 |
| 2 | 10 V | 5 | 4.85 to 5.15 |
| 20 | 100 V | 5 | 4.85 to 5.15 |

### 3. CHECK VOLTS-mA/DIV VAR RANGE

a. Set VOLTS-mA/DIV to 20 m (black scale).

b. Set the Amplitude Calibrator for an output of 0.1 V at 1 kHz.

c. Rotate the VOLTS-mA/DIV VAR control toward fully counterclockwise position.

d. CHECK—VOLTS-mA/DIV VAR range for at least a 2.5:1 ratio (vertical deflection is reduced to two divisions or less).

e. Reset VOLTS-mA/DIV VAR to its calibrated detent.

### 4. CHECK/ADJUST ATTENUATOR COMPENSATION

a. Set:

| | |
|---|---|
| VOLTS-mA/DIV | .2 (black scale) |
| SEC/DIV | .2 m |
| INPUT COUPLING | DC |

b. Set the Amplitude Calibrator for 1 V at 1 kHz and adjust the 213 for a stable display.

c. CHECK—Crt display for a flat-top waveform.

d. ADJUST—10X compensation capacitor C108 (middle unmarked hole in side panel) for the best flat-top waveform.

e. Set VOLTS-mA/DIV to 2 (black scale).

f. Set the Calibrator output to 10 V.

g. CHECK—Crt display for a flat-top waveform.

h. ADJUST—100X compensation capacitor C-104 (top unmarked hole in side panel) for the best flat-top waveform.

i. Set VOLTS-mA/DIV to 20 (black scale).

j. Set the Calibrator output to 100 V.

k. CHECK—Crt display for a flat-top waveform.

l. ADJUST—1000X compensation capacitor C112 (bottom unmarked hole in side panel) for the best flat-top waveform.

m. Disconnect the Calibrator.

**5. CHECK BANDWIDTH**

a. Set: VOLTS-mA/DIV 5 m (black scale)
SEC/DIV .5 m

b. Connect the probe to the Sine-Wave Generator with a dual banana-plug to BNC adapter, 5X attenuator, 50 Ω feedthrough terminator, and a probe adapter. Set the Generator frequency to 10 kHz and its output amplitude for a 6 division crt display.

c. Set the Generator frequency to 400 kHz.

d. CHECK—Vertical deflection is at least 4.2 divisions.

e. Remove the 5X attenuator and 50 Ω terminator from the Generator and reconnect the probe to the Generator with the probe adapter.

f. Set VOLTS-mA/DIV to .2 (black scale).

g. Set the Generator frequency to 10 kHz and its output amplitude for a 6 division crt display.

h. Set the Generator frequency to 1 MHz.

i. CHECK—Vertical deflection is at least 4.2 divisions.

j. Disconnect the Generator.



@

# C. HORIZONTAL SYSTEM

## Equipment Required

1. Time-Mark Generator
2. Sine-Wave Generator
3. Screwdriver
4. Adapter, Probe
5. Adapter, Banana Plug (2 required)
6. Attenuator, 5X
7. Termination, Feedthrough
8. Cable
9. T-Connector

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | .5 (black scale) |
| SEC/DIV | .1 m |
| INPUT COUPLING | DC |
| INTENSITY | Minimum for a visible display |
| TRIGGER | INTL AC AUTO |
| LEVEL-SLOPE | As desired for a stable sweep |
| VOLTS-mA/DIV VAR | Cal detent |
| HORIZ MGF VAR | Cal detent |
| POS | As required for a visible display |

### 1. CHECK SWEEP TIMING ACCURACY

a. Connect the probe to the Time-Mark Generator (trigger output jack) with a probe adapter, set the Generator for a 10 μs marker output, and adjust the LEVEL-SLOPE control for a stable display of the markers.

b. Set the Time-Mark Generator and SEC/DIV control as shown in Table 5-2. The horizontal POS control may need adjustment to align a timing mark with a vertical graticule line.

c. CHECK—Sweep timing accuracy is 1 marker/division within 0.4 division over the center 8 divisions.

d. Disconnect the Generator.

**TABLE 5-2**
**Sweep Timing Accuracy**

| Time-Mark Generator Setting | SEC/DIV Setting |
|---|---|
| 10 μs | 10 μ |
| 50 μs | 50 μ |
| 0.1 ms | .1 m |
| 0.2 ms | .2 m |
| 1 ms | 1 m |
| 2 ms | 2 m |

### 2. CHECK SWEEP MAGNIFIER RANGE

a. Set SEC/DIV at 1 m and the Time-Mark Generator for 1 ms.

b. Rotate HORIZ MGF VAR toward fully clockwise.

c. CHECK—HORIZ MGF VAR range for at least 5:1 ratio (1 marker/5 divisions).

d. Return HORIZ MGF VAR to CAL detent.

### 3. CHECK SWEEP LINEARITY

a. Set the Time-Mark Generator, SEC/DIV, VOLTS-mA/DIV, and HORIZ MGF VAR as shown in Table 5-3.

b. CHECK—Linearity over any 2 divisions of the center 8 divisions is within 0.1 division (5%) excluding the first 1 μs of the sweep.

TABLE 5-3
Sweep Linearity

| SEC/DIV Setting | Time-Mark Generator Setting | VOLTS-mA/DIV Setting (black scale) | HORIZ MGF VAR Setting [1] |
|---|---|---|---|
| 2 $\mu$ | 1 $\mu$s | .1 | CAL detent |
| .5 m | 0.2 ms | .5 | CAL detent |
| 5 $\mu$ | 1 $\mu$s | .1 | Set fully clockwise. Then adjust counterclockwise to 1 marker/division |
| .5 m | 0.1 ms | .5 | Set fully clockwise. Then adjust counterclockwise to 1 marker/division. |

[1] The horizontal POS control may need adjustment to align a timing mark with a vertical graticule line.

c. Return HORIZ MGF VAR to the CAL detent.

d. Disconnect the Generator.

## 4. CHECK INTERNAL TRIGGER

a. Set: VOLTS-mA/DIV — 1 (black scale)
SEC/DIV — .5 m
INPUT COUPLING — DC
TRIGGER — INTL AC AUTO
HORIZ MGF — CAL detent

b. Connect the probe to the Sine-Wave Generator with a dual banana-plug to BNC adapter and a probe adapter. Set the Generator frequency to 1 kHz and adjust the output amplitude for a 0.5 division display.

c. CHECK—Sweep triggers at some point on both the positive and negative slope of the LEVEL-SLOPE control, and free-runs when not triggered.

d. Set TRIGGER to INTL AC NORM.

e. CHECK—Sweep triggers at some point on both the positive and negative slope of the LEVEL-SLOPE control, and there is no sweep when not triggered.

f. Set TRIGGER to INTL AC AUTO and SEC/DIV to 2 $\mu$.

g. Set the Generator to 1 MHz with an output amplitude of 0.5 division.

h. Repeat steps c through e.

i. Disconnect the Generator.

## 5. CHECK EXTERNAL TRIGGER

a. Set: VOLTS-mA/DIV — .5
SEC/DIV — .5 m
TRIGGER — INTL AC AUTO

b. Connect the Sine-Wave Generator to EXT TRIG and the probe using two dual banana-plug to BNC adapters, a T-Connector, a probe adapter, and a cable. Set the Generator to 1 kHz and adjust the output amplitude for a 2 division display (1 V p-p).

c. Set TRIGGER to EXT DC.

d. CHECK—Sweep will trigger at some point on both the positive and negative slope of the LEVEL-SLOPE control (there is no trace when not triggered).

e. Set TRIGGER to INTL AC AUTO and SEC/DIV to 2 $\mu$.

f. Set the Generator to 1 MHz and adjust the output amplitude for a 2 division display (1 V p-p).

g. Repeat steps c and d.

h. Disconnect the Generator.

# D. DIGITAL MULTIMETER MEASUREMENT SYSTEM

## Equipment Required

1. DC Voltage Standard
2. DC Current Standard
3. Resistance Standard
4. Sine-Wave Generator
5. Digital Voltmeter
6. AC Calibration Standard
7. Screwdriver
8. Adapter, Probe
9. Adapter, Banana Plug (2 required)
10. T-Connector
11. Cable

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button in |
| RMS | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 100 (blue scale) |
| INTENSITY | Minimum for a visible display |

### 1. CHECK DECIMAL POINT POSITION

a. Set INPUT COUPLING to GND.

b. CHECK—Decimal point is midway between the 3rd and 4th character.

### 2. CHECK INPUT LEAKAGE CURRENT

a. Set: VOLTS-mA/DIV 0.1 (blue scale)
INPUT COUPLING DC

b. Connect the probe tip and the probe common clip together and note the reading. Then disconnect them and note the reading.

c. CHECK—Readings are within .0020 of each other.

### 3. CHECK CHARACTER GENERATOR

a. Set VOLTS-mA/DIV to 1 (blue scale).

b. Connect the probe to the DC Voltage Standard with a dual banana-plug to BNC adapter and probe adapter. Set the Standard to +1.005 volts.

c. CHECK—Readout displays +1.005.

d. Rotate the Standards 100 mV selector from 0 through 9 (1.005 to 1.905).

e. CHECK—Millivolt digit on the readout displays a 0 through 9 (+1.005 through +1.9005).

### 4. CHECK POLARITY INDICATION

a. Note the polarity of the reading on the display.

b. Reverse the banana plug connector at the Standard.

c. CHECK—Display reverses polarity sign.

d. Reset banana-plug connector for positive inputs.

### 5. CHECK DC VOLTAGE MEASUREMENT ACCURACY

a. Set VOLTS-mA/DIV and the DC Voltage Standard as shown in Table 5-4.

b. CHECK—Reading is within limits shown in Table 5-4.

### 6. CHECK RMS CONVERTER DC VOLTAGE RESPONSE

a. Set RMS pushbutton in.

b. Set VOLTS-mA/DIV to 1 (blue scale).

c. Set the DC Voltage Standard to +1.000 V.

d. CHECK—Reading of 1.000 ± 0.025 (0.975 to 1.025).

TABLE 5-4
DC Voltage Measurement Accuracy

| VOLTS-mA/DIV Setting (blue scale) | DC Voltage Standard Setting | Reading Limits |
|---|---|---|
| 0.1 | +0.2000 V | +.1995 to +.2005 |
| | −0.2000 V | −.1995 to −.2005 |
| 1 | +2.0000 V | +1.997 to +2.003 |
| | −2.0000 V | −1.997 to −2.003 |
| 10 | +20.000 V | +19.96 to +20.04 |
| | −20.000 V | −19.96 to −20.04 |
| 100 | +200.00 V | +199.6 to +200.4 |
| | −200.00 V | −199.6 to −200.4 |
| 1000 | +750.00 V | +0747 to +0753 |
| | −750.00 V | −0747 to −0753 |

e. Reset RMS pushbutton to out.

f. Disconnect the Standard.

## 7. CHECK DC CURRENT MEASUREMENT ACCURACY

a. Set mA pushbutton in.

b. Connect the DC Current Standard to the mA-Ω and common jacks using two banana jacks to BNC adapters and a cable.

c. Set VOLTS-mA/DIV and the Standard as shown in Table 5-5.

d. CHECK—Reading is within limits shown in Table 5-5.

e. Disconnect the Standard.

## 8. CHECK RESISTANCE MEASUREMENT ACCURACY

a. Set Ω pushbutton in.

b. Connect the Resistance Standard to the mA-Ω and common jacks using two banana plug to BNC adapters and a cable.

TABLE 5-5
DC Current Measurement Accuracy

| VOLTS-mA/DIV Setting (blue scale) | DC Current Standard Setting | Reading Limits |
|---|---|---|
| 0.1 | ALL ZEROS | −.0003 to +.0003 |
| 0.1 | +0.1 mA | +.0992 to +.1008 |
| 1 | +1 mA | +0.994 to +1.006 |
| 10 | +10 mA | +09.94 to +10.06 |
| 100 | +100 mA | +099.4 to +100.6 |
| 1000 | +1 A | +0994 to +1006 |

TABLE 5-6
Resistance Measurement Accuracy

| VOLTS-mA/DIV Setting | Resistance Standard Setting | Reading Limits |
|---|---|---|
| 1 kΩ | 0.500 Ω | 0.494 to 0.506 |
| 10 kΩ | 5.00 kΩ | 04.96 to 05.04 |
| 100 kΩ | 50.0 kΩ | 049.6 to 050.4 |
| 1 MΩ | 500 kΩ | 0.496 to 0.504 |
| 10 MΩ | 5.00 MΩ | 04.94 to 05.06 |

c. Set VOLTS-mA/DIV and the Resistance Standard as shown in Table 5-6.

d. CHECK—Reading is within limits shown in Table 5-6.

e. Disconnect the Standard.

## 9. CHECK RMS VOLTAGE MEASUREMENT ACCURACY

**NOTE**

*This procedure verifies the specified accuracy of the 213, but does not check all the ranges. For further information, refer to the following in Section 6: (a) Calibration steps 12 and 12A; (b) Item 5 and foot note 3 in Table 6-1.*

a. Connect the Digital Voltmeter and the probe to the Amplitude Calibrator with a T-connector, dual banana plug to BNC adapter, probe adapter, and a cable. Set the Calibrator for a square-wave output.

b. Set INPUT COUPLING to AC.

c. Set VOLTS-mA/DIV and Calibrator as shown in Table 5-7.

d. CHECK—Reading is within limits shown in Table 5-7.

e. Disconnect the Voltmeter and Calibrator.

**TABLE 5-7**
**RMS Voltage Measurement Accuracy**

| VOLTS-mA/DIV Setting (blue scale) | Amplitude Calibrator Setting | Reading Limits |
|---|---|---|
| 0.1 | 0.2 V | This reading should be the same as the Digital Voltmeter for the same number of digits. |
| 1 | 2 V | |
| 10 | 20 V | |
| 100 | 100 V | |

## 10. CHECK RMS CURRENT MEASUREMENT ACCURACY

**NOTE**

*This check requires the use of the AC Calibration Standard. For further information, refer to the following in Section 6: (a) Calibration procedure step 13; (b) Item 5 and footnote 3 in Table 6-1.*

a. Set mA pushbutton in.

b. Connect the AC Calibration Standard (Current configuration) to the mA-Ω and common jacks using two banana plug to BNC adapters and a cable.

c. Set VOLTS-mA/DIV and the Standard as shown in Table 5-8.

d. CHECK—Reading is within limits shown in Table 5-8.

e. Disconnect Standard.

**TABLE 5-8**
**RMS Current Measurement Accuracy**

| VOLTS-mA/DIV Setting (blue scale) | AC Calibration Standard Setting (set at 40 kHz) | Reading Limits |
|---|---|---|
| 0.1 | 0.200 mA | .1950 to .2050 |
| 1 | 2.00 mA | 1.925 to 2.075 |
| 10 | 20.00 mA | 19.25 to 20.75 |
| 100 | 200.0 mA | 192.5 to 207.5 |
| 1000 | 1000 mA | 0925 to 1075 |

# CALIBRATION

## PRELIMINARY INFORMATION

### Calibration Interval

To assure instrument accuracy, check the calibration of the 213 every 1000 hours of operation, or every 6 months if used infrequently. Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

### Tektronix Field Service

Tektronix, Inc. provides complete instrument repair and recalibration at local Field Service Centers and the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

### Using This Procedure

This section provides several features to facilitate calibration of the 213. These are:

**INDEX.** An index is given preceding the Calibration procedure to aid in locating steps.

**CONTROL SETTINGS.** Control settings precede each major function to be calibrated. Titles for external controls are fully capitalized in the procedure (e.g. INTENSITY) and internal adjustments are initial capitalized only (e.g. Ohms Cal).

**COMPLETE CALIBRATION PROCEDURE.** Completion of each step in the complete Calibration procedure ensures that this instrument is correctly adjusted and performing within all given tolerances.

**PARTIAL CALIBRATION.** A partial calibration is often desirable after replacing components, or to touch up the adjustment of a portion of the instrument between major recalibrations. To calibrate only part of the instrument, set the controls as given under Control settings at the beginning of the major instrument section for that particular portion. To prevent unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the CHECK— part of the step is not met.

## EQUIPMENT REQUIRED

The test equipment and accessories given in Table 6-1, or its equivalent, are required for complete calibration of the 213. Specifications given for the test equipment are the minimum necessary for adequate calibration. Therefore, the specifications of any test equipment used must meet or exceed the listed specifications. All test equipment is assumed to be correctly calibrated and operating within the listed specifications. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

### Special Calibration Fixtures

Special Tektronix calibration fixtures are used in this procedure only where they facilitate instrument calibration. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your Tektronix Field Office or representative.

### Calibration Equipment Alternatives

All of the listed test equipment, or its equivalent, is required to completely check and adjust this instrument. The Calibration procedure is based on the first item of equipment given as an example in the Equipment Required list. If the exact item is not available, first check the Specifications column carefully to see if any other equipment is available which might suffice. Then check the Purpose column to see what this item of test equipment is used for. If used for a check or adjustment that is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

Complete checking or calibration may not always be necessary or desirable. The user may be satisfied with checking only selected characteristics, thereby reducing the amount of test equipment actually required. The equipment required for the actual calibration adjustments in the procedure are identified in Table 6-1 with a footnote (1).

TABLE 6-1
Equipment Required

| Description | Minimum Specifications | Purpose | Example of Applicable Test Equipment |
|---|---|---|---|
| 1. Digital Voltmeter[1] | Range, 0.1 to 1000 volts dc and true rms; accuracy, within 0.1% from dc to 1 kHz and 0.6% at 40 kHz. | Power supply check and adjustment; rms converter check and adjustment; battery charger check; and crt grid bias check and adjustment. | Fluke Model 8375A Digital Voltmeter. |
| 2. DC Voltage Standard[1] | Range, 0.1 to 800 volts; accuracy, within 0.01%. | Dc voltage accuracy check and adjustment; overrange check; character generator check; rms converter dc response check. | Fluke Model 341A or 343A Voltage Calibrator. |
| 3. DC Current Standard | Range, 0.1 to 1000 mA; accuracy, within 0.02%. | Dc current measurement accuracy check. | Fluke Model 382A Voltage/Current Calibrator. |
| 4. Resistance Standard[1] | Range, 500 Ω to 5 MΩ accuracy, within 0.05%. | Resistance check and adjustment. | Electro Scientific Industries Model DB62 Dekabox. |
| 5. AC Calibration Standard[3] | Range, 10 mV to 500 V; frequency output, 1 kHz to at least 1 MHz; accuracy, within 0.5% for voltage and 2% for frequency. | Ac voltage and current Measurement accuracy check. | Optimation Model AC-126 AC-DC Voltage Calibrator with Model PA-226 Power Amplifier and Model CS-11-/2206 Current Calibrator. |
| 6. Sine-Wave Generator[1] | Frequency Range, 1 kHz to at least 1 MHz; output, 0.1 to at 5.5 V p-p. | Bandwidth check; trigger level and slope check and adjustment; rms converter check and adjustment. | General Radio Model 1310A or 1310B Oscillator. |
| 7. Amplitude Calibrator[1] | Output, 20 mV to 100 V at 1 kHz; accuracy, 0.3%. | Vertical gain check and adjustment; attenuator compensation check and adjustment; variable vertical gain check. | Tektronix Part No. 067-0502-01, Standard Amplitude Calibrator. |
| 8. Time-Mark Generator[1] | Marker outputs, 2 μs to 0.2 s in 1-2-5 sequence; accuracy, within 0.1%. | Sweep timing check and adjustment; horizontal magnifier check; sweep linearity check. | a. Tektronix TG 501 Time-Mark Generator[2].<br>b. Tektronix 2901 Time-Mark Generator. |
| 9. Screwdriver, Low Capacitance | Bit size, 3/32 inch; shank, at least 3 inches. | Used throughout procedure to adjust variable capacitors. | JFD Electronics Corp adjustment tool, Number 5284 (Tektronix Part No. 003-0489-00). |
| 10. Screwdriver | Bit size, 3/32 inch; shank, at least 3 inches. | Used throughout procedure to adjust variable components. | Xcelite R-3323 (Tektronix Part No. 003-0192-00). |

[1] Required for calibration adjustments. Other equipment is required to check performance specifications.

[2] Requires a TM 500 series Power Module.

[3] This is a high cost item which is required to verify the accuracy of the 213 for ac (rms) voltage and current measurements. It is not required to perform the calibration adjustments. Refer to the Check RMS Voltage Measurement Accuracy calibration procedure for further information.

TABLE 6-1 (cont.)
Equipment Required

| Description | Minimum Specifications | Purpose | Example of Applicable Test Equipment |
|---|---|---|---|
| 11. T-Connector | Connectors, BNC male to two BNC females. | Trigger check; rms converter check and adjustment. | Tektronix Part Number 103-0030-00. |
| 12. Adapter | Connector, probe tip to BNC male. | Used throughout procedure to connect the 213 probe to the test equipment. | Tektronix Part Number 013-0084-01. |
| 13. Adapter (2 required) | Connector, BNC female to dual banana plug. | External trigger check. | Tektronix Part Number 103-0090-00. |
| 14. Cable | Impedance, 50 Ω; type, RG-58/U; length, as required; connectors, BNC male. | Signal interconnection. | Tektronix Part Number 012-0057-01 (42 inch). |
| 15. Attenuator, 5X | Impedance, 50 Ω; connectors, BNC. | Used for bandwidth check. | Tektronix Part Number 011-0060-02. |
| 16. Termination, feed-through | Impedance, 50 Ω; connectors, BNC. | Used for bandwidth check. | Tektronix Part Number 011-0049-01. |

## EQUIPMENT PREPARATION

For the best overall accuracy and performance, this instrument should be calibrated in an ambient temperature of 25°C ± 5°C.

Remove the instrument cabinet as described in the Cabinet Removal instructions in the Maintenance section.

Turn the instrument on and allow at least a 10 minute warmup time before proceeding. If the instrument is operating on batteries and is stabilized at the ambient temperature, no more than a 10 second warm up period is required.

If the batteries are not fully charged, connect the instrument to the correct power line voltage for approximately 1 hour before continuing with calibration. Leave the instrument connected to the power line during calibration unless the batteries are fully charged.

**WARNING**

*Potentially dangerous high voltages, which create a possible shock hazard, exist inside this instrument when it is operating with the cabinet removed. Do not remove protective shields unless the instrument is turned off and the power plug is removed from the power line.*

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# A. POWER SUPPLY AND DISPLAY

## Equipment Required

1. Digital Voltmeter
2. Screwdriver

For adjustments and test points (TP), see ADJUSTMENT LOCATIONS pullout page in the Diagrams section.

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 1 (black scale) |
| SEC/DIV | 1 m |
| INPUT COUPLING | GND |
| TRIGGER | INTL AC AUTO |
| INTENSITY | Full ccw |
| LEVEL-SLOPE | Midrange of either slope (do not set at midrange of control) |
| VOLTS-mA/DIV VAR | CAL detent |
| HORIZ MGF VAR | CAL detent |

### 1. CHECK/ADJUST LOW-VOLTAGE POWER SUPPLIES

a. Connect the Digital Voltmeter between TP545 (+15 V) and common.

b. CHECK—Reading is +15.00 V ± 0.15 V.

c. ADJUST—+15 V Adj, R467, for reading of +15.00 V.

d. Connect the Digital Voltmeter between each of the test points shown in Table 6-2 and common.

e. CHECK—Readings are within tolerance shown.

TABLE 6-1
Power Supply Voltage Tolerance

| Test Point | Reading Tolerance |
|---|---|
| TP550 (+6.5 V) | +6.5 V ± 0.3 V |
| TP555 (−6.5 V) | −6.4 V ± 0.3 V |
| TP540 (+75 V) | +75 V ± 3 V |

### 2. CHECK/ADJUST HIGH-VOLTAGE POWER SUPPLY

a. Connect the Digital Voltmeter between TP530 (−1000 V) and common.

b. CHECK—Reading is −1000 V ± 10 V.

c. ADJUST—HV Adj, R525, for reading of −1000 V.

### 3. CHECK BATTERY CHARGER OPERATION

a. Connect the Digital Voltmeter to the Battery Charger Test Point.

b. Connect the instrument power plug to the power line.

c. For SN B030000 - up, CHECK – Reading of +0.020 to +0.024. ADJUST – R448 Charge Adjust, for +0.022. For SN below B030000, CHECK—Reading of +0.20 to +0.030.

d. Disconnect the instrument power plug from the power line.

e. CHECK—Reading of −0.035 to −0.075.

f. Disconnect the Digital Voltmeter.

g. If the batteries were not charged at the beginning of the calibration procedure, reconnect the instrument to the power line.

## 4. CHECK/ADJUST CRT GRID BIAS

a. Connect the Digital Voltmeter between TP527 (Beam .28 V) and common.

b. Set INTENSITY fully clockwise.

c. CHECK—Reading is +0.28 V ± .01 V.

d. ADJUST—Grid Drive, R535, for reading of +0.28 V.

## 5. CHECK/ADJUST UNBLANKING, FOCUS, AND ASTIGMATISM

a. ADJUST—Blank, R580, for maximum brightness (reduce INTENSITY as required to maintain a visible trace without blooming).

b. Set SEC/DIV to .5 (spot will slowly sweep across the screen).

c. CHECK—Spot is well defined.

d. ADJUST—FOCUS, R565 and Astig, R575, for the best spot definition.

e. Reset SEC/DIV to 1 m.

## 6. CHECK/ADJUST TRACE ROTATION

a. Vertically position the trace on the center horizontal graticule line.

b. CHECK—Trace is parallel to the center horizontal graticule line.

c. ADJUST—TRACE ROTATE, R570, to make trace parallel to the center horizontal graticule line.

# B. VERTICAL SYSTEM

## Equipment Required

1. Amplitude Calibrator
2. DC Voltage Standard
3. Sine-Wave Generator
4. Probe Adapter
5. Screwdriver
6. Low Capacitance Screwdriver
7. Attenuator, 5X
8. Termination, Feedthrough
9. Adapter, Banana Plug

**For adjustments and test points (TP), see ADJUSTMENT LOCATIONS pullout page in the Diagrams section.**

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button in |
| RMS | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 0.1 (blue scale) |
| INPUT COUPLING | GND |
| INTENSITY | Minimum for a visible display |

### 1. CHECK/ADJUST DC BALANCE AND DC ZERO

a. Alternately select the 0.1 V and 1 V range (blue scale) on the VOLTS-mA/DIV switch.

b. CHECK—Display has the same count (approximately zero) and polarity sign in both switch positions.

c. ADJUST—DC BAL, R145, for the same count and polarity sign.

d. Remove the DC Cal Jumper wire (see Figure 9-4).

e. Repeat steps a through c.

f. ADJUST—DC Zero, R185, for a minimum reading.

g. Replace the DC Cal Jumper wire.

### 2. CHECK/ADJUST 10X GAIN

a. Set: VOLTS-mA/DIV 0.1 (blue scale)
INPUT COUPLING DC

b. Connect the probe to the DC Voltage Standard with a dual banana-plug to BNC adapter and a probe adapter. Set the Standard to +0.20000 volts.

c. CHECK—Reading of +.2000 ± .0005 (+.1995 to +.2005).

d. ADJUST—10X Gain, R152, for reading of +.2000.

e. Disconnect the Standard.

### 3. CHECK/ADJUST VERTICAL GAIN

a. Set: DMM Button out
VOLTS-mA/DIV 20 m (black scale)
SEC/DIV 1 m
LEVEL-SLOPE Midrange of either slope (do not set at midrange of the control)

b. Connect the probe to the Amplitude Calibrator with a probe adapter. Set the Calibrator for an output of 0.1 V at 1 kHz and adjust for a stable display.

c. CHECK—Vertical deflection of 5 divisions ± 0.25 division (4.75 to 5.25 div).

d. ADJUST—VERT GAIN, R132, for 5 divisions of deflection.

e. Set VOLTS-mA/DIV and Calibrator as shown in Table 6-3.

f. CHECK—Vertical deflection accuracy is within limits shown in Table 6-3.

**TABLE 6-3**
**Vertical Deflection Accuracy**

| VOLTS-mA/DIV Setting (black scale) | Amplitude Calibrator Setting | Deflection (Divisions) | Limits (Divisions) |
|---|---|---|---|
| 10 m | 50 mV | 5 | 4.85 to 5.15 |
| .5 | 2 V | 4 | 3.88 to 4.12 |
| 2 | 10 V | 5 | 4.85 to 5.15 |
| 20 | 100 V | 5 | 4.85 to 5.15 |

## 4. CHECK VOLTS-mA/DIV VAR RANGE

a. Set VOLTS-mA/DIV to 20 m (black scale).

b. Set the Amplitude Calibrator for an output of 0.1 V at 1 kHz.

c. Rotate the VOLTS-mA/DIV VAR control toward a fully counterclockwise position.

d. CHECK—VOLTS-mA/DIV VAR range for at least a 2.5:1 ratio (vertical deflection is reduced to two divisions or less).

e. Reset VOLTS-mA/DIV VAR to its calibrated detent.

## 5. CHECK/ADJUST ATTENUATOR COMPENSATION

a. Set: VOLTS-mA/DIV .2 (black scale)
SEC/DIV .2 m
INPUT COUPLING DC

b. Set the Amplitude Calibrator for 1 V at 1 kHz and adjust the 213 for a stable display.

c. CHECK—Crt display for a flat-top waveform.

d. ADJUST—10X compensator capacitor C108 (middle unmarked hole in side panel) for the best flat-top waveform.

e. Set VOLTS-mA/DIV to 2 (black scale).

f. Set the Calibrator output to 10 V.

g. CHECK—Crt display for a flat-top waveform.

h. ADJUST—100X compensator capacitor C104 (top unmarked hole in side panel) for the best flat-top waveform.

i. Set VOLTS-mA/DIV to 20 (black scale).

j. Set the Calibrator output to 100 V.

k. CHECK—Crt display for a flat-top waveform.

l. ADJUST—1000X compensator capacitor, C112 (bottom unmarked hole in side panel) for the best flat-top waveform.

m. Disconnect the Calibrator.

## 6. CHECK BANDWIDTH

a. Set: VOLTS-mA/DIV 5 m (black scale)
SEC/DIV .5 m

b. Connect the probe to the Sine-Wave Generator with a dual banana-plug to BNC adapter, 5X attenuator, 50 Ω feedthrough terminator, and a probe adapter. Set the Generator frequency to 10 kHz and its output amplitude for a 6 division crt display.

c. Set the Generator frequency to 400 kHz.

d. CHECK—Vertical deflection is at least 4.2 divisions.

e. Remove the 5X attenuator and 50Ω terminator from the Generator and reconnect the probe to the Generator with the probe adapter.

f. Set VOLTS-mA/DIV to .2 (black scale).

g. Set the Generator frequency to 10 kHz and its output amplitude for a 6 division crt display.

h. Set the Generator frequency to 1 MHz.

i. CHECK–Vertical deflection is at least 4.2 divisions.

j. Disconnect the Generator.

# C. HORIZONTAL SYSTEM

## Equipment Required

1. Time-Mark Generator
2. Sine-Wave Generator
3. Screwdriver
4. Adapter, Probe
5. Adapter, Banana Plug (2 required)
6. Attenuator, 5X
7. Termination, Feedthrough
8. Cable
9. T-Connector

For adjustments and test points (TP), see ADJUSTMENT LOCATIONS pullout page in the Diagrams section.

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | .5 (black scale) |
| SEC/DIV | .1 m |
| INPUT COUPLING | DC |
| INTENSITY | Minimum for a visible display |
| TRIGGER | INTL AC AUTO |
| LEVEL-SLOPE | As desired for a stable sweep |
| VOLTS-mA/DIV VAR | Cal detent |
| HORIZ MGF VAR | Cal detent |
| POS | As required for a visible display |

### 1. CHECK/ADJUST SWEEP TIMING

a. Connect the probe to the Time-Mark Generator (trigger output jack) with a probe adapter. Set the generator for 0.1 ms markers.

b. CHECK—1 marker/division within 0.4 division over the center 8 divisions.

c. ADJUST—Sweep Cal, R312, for 1 marker/division over the center 8 divisions.

d. Set the Time-Mark Generator, SEC/DIV, and VOLTS-mA/DIV as shown in Table 6-4. The horizontal POS control may need adjustment to align a timing mark with a vertical graticule line.

e CHECK—1 marker/division within 0.4 division over the center 8 divisions.

f. Disconnect the Generator.

### 2. CHECK SWEEP MAGNIFIER RANGE

a. Set SEC/DIV at 1 m and the Time-Mark Generator for 1 ms.

b. Rotate HORIZ MGF VAR toward fully clockwise.

c. CHECK—HORIZ MGF VAR range for at least 5:1 ratio (1 marker/5 divisions).

d. Return HORIZ MGF VAR to CAL detent.

TABLE 6-4
Sweep Timing Accuracy

| Time-Mark Generator Setting | SEC/DIV Setting | VOLTS-mA/DIV Setting (black scale) |
|---|---|---|
| 2 μs | 2 μ | .1 |
| 5 μs | 5 μ | .2 |
| 10 μs | 10 μ | .5 |
| 20 μs | 20 μ | .5 |
| 50 μs | 50 μ | .5 |
| 0.1 ms | .1 m | .5 |
| 0.2 ms | .2 m | .5 |
| 0.5 ms | .5 m | .5 |
| 1 ms | 1 m | .5 |
| 2 ms | 2 m | .5 |
| 5 ms | 5 m | .5 |

TABLE 6-5
Sweep Linearity

| SEC/DIV | Time-Mark Generator Setting | VOLTS-mA/DIV Setting (black scale) | HORIZ MGF VAR Setting [1] |
|---|---|---|---|
| 2 μ | 1 μs | .1 | CAL detent |
| .5 m | 0.2 ms | .5 | CAL detent |
| 5 μ | 1 μs | .1 | Set fully clockwise. Then adjust counterclockwise to 1 marker/division. |
| .5 m | 0.1 ms | .5 | Set fully clockwise. Then adjust counterclockwise to 1 marker/division. |

[1] **The horizontal POS control may need adjustment to align a timing mark with a vertical graticule line.**

### 3. CHECK SWEEP LINEARITY

a. Set the Time-Mark Generator, SEC/DIV, VOLTS-mA/DIV, and HORIZ MGF VAR as shown in Table 6-5.

b. CHECK—Linearity over any two divisions of the center eight divisions is within 0.1 division (5%) excluding the first 1 μs of the sweep.

c. Return HORIZ MGF VAR to the CAL detent.

d. Disconnect the Generator.

### 4. CHECK INTERNAL TRIGGER

a. Set:

| | |
|---|---|
| VOLTS-mA/DIV | 1 (black scale) |
| SEC/DIV | .5 m |
| INPUT COUPLING | DC |
| TRIGGER | INTL AC AUTO |
| HORIZ MGF | CAL detent |

b. Connect the probe to the Sine-Wave Generator with a dual banana plug to BNC adapter and a probe adapter. Set the Generator frequency to 1 kHz and adjust the output amplitude for a 0.5 division display.

c. CHECK—Sweep triggers at some point on both the positive and negative slope of the LEVEL-SLOPE control, and free-runs when not triggered.

d. Set TRIGGER to INTL AC NORM.

e. CHECK—Sweep triggers at some point on both the positive and negative slope of the LEVEL-SLOPE control, and there is no sweep when not triggered.

f. Set TRIGGER to INTL AC AUTO and SEC/DIV to 2 μ.

g. Set the Generator to 1 MHz with an output amplitude of 0.5 division.

h. Repeat steps c through e.

i. Disconnect the Generator.

## 5. CHECK EXTERNAL TRIGGER

a. Set: VOLTS-mA/DIV .5

SEC/DIV .5 m

TRIGGER INTL AC AUTO

b. Connect the Sine-Wave Generator to EXT TRIG and the probe using two dual banana-plug to BNC adapters, a T-Connector, a probe adapter, and a cable. Set the Generator to 1 kHz and adjust the output amplitude for a 2 division display (1 V p-p).

c. Set TRIGGER to EXT DC.

d. CHECK—Sweep will trigger at some point on both the positive and negative slope of the LEVEL-SLOPE control (there is no trace when not triggered).

e. Set TRIGGER to INTL AC AUTO and SEC/DIV to 2 $\mu$.

f. Set the Generator to 1 MHz and adjust the output amplitude for a 2 division display (1 V p-p).

g. Repeat steps c and d.

h. Disconnect the Generator.

# D. DIGITAL MULTIMETER MEASUREMENT SYSTEM

## Equipment Required

1. DC Voltage Standard
2. DC Current Standard
3. Resistance Standard
4. Sine-Wave Generator
5. Digital Voltmeter
6. AC Calibration Standard
7. Screwdriver
8. Adapter, Probe
9. Adapter, Banana-Plug (2 required)
10. T-Connector
11. Cable

For adjustments and test points (TP), see ADJUSTMENT LOCATIONS pullout page in the Diagrams section.

## Control Settings

| | |
|---|---|
| POWER | ON |
| DMM | Button in |
| RMS | Button out |
| VOLTS | Button in |
| VOLTS-mA/DIV | 100 (blue scale) |
| INPUT COUPLING | GND |
| INTENSITY | Minimum for a visible display |

### 1. CHECK/ADJUST DECIMAL POINT POSITION

a. CHECK—Decimal point is midway between the 3rd and 4th character.

b. ADJUST—Character Spacing Adj., R280, so the decimal point is midway between the 3rd and 4th character.

### 2. CHECK INPUT LEAKAGE CURRENT

a. Set: VOLTS-mA/DIV 0.1 (blue scale)
INPUT COUPLING DC

b. Connect the probe tip and the probe common clip together and note the reading. Then disconnect them and note the reading.

c. CHECK—Readings are within .0020 of each other.

### 3. CHECK/ADJUST DC CALIBRATION

a. Set: VOLTS-mA/DIV 1 (blue scale)
INPUT COUPLING GND

b. Recheck steps B1a and B1b, and if necessary, B1c. If reading is not 0.000, recheck step B1d through B1g.

c. Set INPUT COUPLING to DC.

d. Connect the probe to the DC Voltage Standard with a dual banana plug to BNC adapter and probe adapter. Set the Standard to +2.000 volts.

e. CHECK—Reading of +2.000 ± .003 (+1.997 to +2.003).

f. ADJUST—DC Cal, R235, for a reading of +2.000.

g. Set Standard to +3.000 volts.

h. CHECK—Reading displays an overrange condition (scrambled character segments or 8's).

## 4. CHECK CHARACTER GENERATOR

a. Set the DC Voltage Standard to +1.005 volts.

b. Rotate the Standards 100 mV selector from 0 through 9 (1.005 to 1.905).

c. CHECK—Millivolt digit on the readout displays a 0 through 9 (+1.005 to +1.905).

## 5. CHECK POLARITY INDICATION

a. Note the polarity of the reading on the display.

b. Reverse the banana plug connector at the Standard.

c. CHECK—The display reverses polarity sign.

d. Reset banana plug connector for positive inputs.

## 6. CHECK DC VOLTAGE MEASUREMENT ACCURACY

a. Set VOLTS-mA/DIV and the DC Voltage Standard as shown in Table 6-6.

b. CHECK—Reading is within limits shown in Table 6-6.

c. Disconnect the Standard.

## 7. CHECK DC CURRENT MEASUREMENT ACCURACY

a. Set: VOLTS-mA/DIV 0.1 (blue scale)

mA Button in

b. Connect the DC Current Standard to the mA-Ω and common jacks using two banana-plug to BNC adapters and a cable.

**TABLE 6-6**
**DC Voltage Measurement Accuracy**

| VOLTS-mA/DIV Setting (blue scale) | DC Voltage Standard Setting | Reading | Limits |
|---|---|---|---|
| 0.1 | +0.1000 V | +.1000 | +.0996 to +.1004 |
| | −0.1000 V | −.1000 | −.0996 to −.1004 |
| 10 | +20.00 V | +20.00 | +19.96 to +20.04 |
| | −20.00 V | −20.00 | −19.96 to −20.04 |
| 100 | +200.0 V | +200.0 | +199.6 to +200.4 |
| | −200.0 V | −200.0 | −199.6 to −200.4 |
| 1000 | +750 V | +0750 | +0747 to +0753 |
| | −750 V | −750 | −0747 to −0753 |

c. Set VOLTS-mA/DIV and the Standard as shown in Table 6-7.

d. CHECK—Reading is within limits shown in Table 6-7.

e. Disconnect the Standard.

**TABLE 6-7**
**DC Current Measurement Accuracy**

| VOLTS-mA/DIV Setting (blue scale) | DC Current Standard Setting | Reading | Limits |
|---|---|---|---|
| 0.1 | all zeros | .0000 | −.0003 to +.0003 |
| 0.1 | +0.1 mA | +.1000 | +.0992 to +.1008 |
| 1 | +1 mA | +1.000 | +0.994 to +1.006 |
| 10 | +10 mA | +10.00 | +09.94 to +10.06 |
| 100 | +100 mA | +100.0 | +099.4 to +100.6 |
| 1000 | +1 A | +1000 | +0994 to +1006 |

## 8. CHECK/ADJUST OHMS CALIBRATION

a. Set: Ω Button in

VOLTS-mA/DIV 10 kΩ

b. Connect the Resistance Standard to the mA-Ω and common jacks using two banana plug to BNC adapters and a cable. Set the Standard to 20 kΩ.

c. CHECK—Reading is 20.00 ± 0.11 (19.89 to 20.11).

d. ADJUST—Ohms Adj, R215, for a reading of 20.00.

## 9. CHECK RESISTANCE MEASUREMENT ACCURACY

a. Set VOLTS-mA/DIV and the Resistance Standard as shown in Table 6-8.

b. CHECK—Reading is within limits shown in Table 6-8.

c. Disconnect the Standard.

**TABLE 6-8**
**Resistance Measurement Accuracy**

| VOLTS-mA/DIV Setting | Resistance Standard Setting | Reading | Limits |
|---|---|---|---|
| 1 kΩ | 0.500 Ω | 0.500 | 0.494 to 0.506 |
| 10 kΩ | 5.00 kΩ | 05.00 | 04.96 to 05.04 |
| 100 kΩ | 50.0 kΩ | 050.0 | 049.6 to 050.4 |
| 1MΩ | 500 kΩ | 0.500 | 0.496 to 0.504 |
| 10 MΩ | 5.00 MΩ | 05.00 | 04.94 to 05.06 |

## 10. CHECK/ADJUST RMS CONVERTER

a. Set: VOLTS Button in
RMS Button in
VOLTS-mA/DIV 1 (blue scale)
INPUT COUPLING AC

b. Connect the Digital Voltmeter and the probe to the Sine-Wave Generator with two dual banana-plug to BNC adapters, a T-Connector, a probe adapter, and a cable. Set the Generator for a 1 kHz frequency output.

c. Set the Generator for a 0.150 V rms output (check against Digital Voltmeter).

**NOTE**

*If the output amplitude control on the Generator is not sensitive enough to be adjusted to exactly 0.150 V rms in the above step, or to exactly 1.500 V rms is a later step, set it to a stable setting that is as close as possible to the specified voltage. When this is done, the CHECK step reading must be modified to that shown on the Digital Voltmeter plus or minus the tolerance given in the CHECK step (e.g. if the generator is set such that the Digital Voltmeter reads 0.157, then the 213 should read 0.157 ± 0.007, which is a limit reading of 0.150 to 0.164). When making the AC Zero and AC Gain adjustments, these must be made to the exact reading on the Digital Voltmeter rather than to the reading specified in the ADJUST step (e.g. in the example above, AC Zero would be adjusted to 0.157 instead of 0.150).*

d. CHECK—Reading of 0.150 ± 0.007 (0.143 to 0.157).

e. ADJUST—AC Zero, R195, for 0.150.

f. Set the Generator to 1.500 V rms (check against Digital Voltmeter).

g. CHECK—Reading of 1.500 ± 0.020 (1.480 to 1.520).

h. ADJUST—AC Gain R188, for 1.500.

i. Repeat steps c through i until there is no error.

## 11. CHECK RMS CONVERTER DC VOLTAGE RESPONSE

a. Set: RMS Button in
INPUT COUPLING DC

b. Connect the probe to the DC Voltage Standard with a dual banana-plug to BNC adapter and a probe adapter. Set the output for +0.100 V.

c. CHECK—Reading of +0.100 ± 0.007 (0.093 to 0.107).

d. Set the Standard output to +1.000 V.

e. CHECK—Reading of +1.000 ± 0.025 (0.975 to 1.025).

f. Disconnect the Standard.

## 12. CHECK RMS VOLTAGE MEASUREMENT ACCURACY

**NOTE**

*The AC Calibration Standard is required to verify the specified accuracy of each rms voltage range with this procedure (step 12). See footnote 3 in Table 6-1. If an AC Calibration Standard is not available, the following procedures are provided as alternatives to the procedure following this note.*

*(a) If all previous calibration steps have been accomplished, each circuit function involved in rms voltage measurement has been checked and adjusted; therefore, further rms voltage measurement accuracy checks may not be necessary for the instruments intended use.*

*(b) The procedure and equipment used in Calibration step 10 can also be used to verify the 0.1, 1, 10, and 100 V rms ranges. The 1000 V range can be checked, but the output of the Sinewave Generator is not sufficient to provide the minimum 10% of full scale input to verify the performance specification.*

*(c) Calibration step 12A is an alternate method of verifying the 0.1, 1, 10, and 100 V rms ranges. The 1000 V range also can be checked with this alternate procedure, but the rms value of the 100 V fixed output of the Amplitude Calibrator is not sufficient (at least 10% of full scale) to verify the performance specification.*

a. Set INPUT COUPLING to AC.

b. Connect the probe to the AC Calibration Standard (Voltage configuration) with a dual banana-plug to BNC adapter and a probe adapter.

c. Set VOLTS—mA/DIV and the Standard as show in Table 6-9.

d. CHECK—Reading is within limits shown in Table 6-9.

e. Disconnect the Standard.

**TABLE 6-9**
**RMS Voltage Measurement Accuracy**

| VOLTS-mA/DIV Setting (blue scale) | AC Calibration Standard Setting (set at 4 kHz and 40 kHz) | Reading | Limits | |
|---|---|---|---|---|
| | | | 4 kHz | 40 kHz |
| 0.1 | 0.0100 | .0100 | .0093 to .0107 | .0091 to .0109 |
| | 0.2000 | .2000 | .1965 to .2035 | .1925 to .2075 |
| 1 | 0.100 | 0.100 | 0.094 to 0.106 | 0.094 to 0.106 |
| | 2.000 | 2.000 | 1.975 to 2.025 | 1.975 to 2.025 |
| 10 | 1.000 | 01.00 | 00.94 to 01.06 | 00.94 to 01.06 |
| | 20.00 | 20.00 | 19.75 to 20.25 | 19.75 to 20.25 |
| 100 | 10.00 | 010.0 | 009.4 to 010.6 | 009.4 to 010.6 |
| | 200.0 | 200.0 | 197.5 to 202.5 | 197.5 to 202.5 |
| 1000 | 100.0 | 0100 | 0094 to 0106 | 0093 to 0107 |
| | 500.0 | 0500 | 0490 to 0510 | 0485 to 0515 |

## 12A. ALTERNATE CHECK OF RMS VOLTAGE MEASUREMENT ACCURACY

**NOTE**

*This procedure assures the specified accuracy of the 213, but does not check all ranges (see Note in Calibration step 12).*

a. Connect the Digital Voltmeter and the probe to the Amplitude Calibrator with a T-Connector, dual banana-plug to BNC adapter, probe adapter, and a cable. Set the Calibrator for a square wave output.

b. Set INPUT COUPLING to AC.

c. Set VOLTS-mA/DIV and Calibrator as shown in Table 6-10.

d. CHECK—Reading is within limits shown in Table 6-10.

e. Disconnect the Voltmeter and Calibrator.

TABLE 6-10
Alternate RMS Voltage Measurement Accuracy

| VOLTS-mA/DIV Setting (blue scale) | Amplitude Calibrator Settings | Limits |
|---|---|---|
| 0.1 | 0.2 V | This reading should be the same as the Digital Voltmeter for the same number of digits |
| 1 | 2 V | |
| 10 | 20 V | |
| 100 | 100 V | |

## 13. CHECK RMS CURRENT MEASUREMENT ACCURACY

**NOTE**

*To verify the specified accuracy of the rms current ranges with the procedure below, requires the use of the AC Calibration Standard (see footnote 3 in Table 6-1). If all previous calibration steps have been accomplished, each circuit function involved in rms current measurement has been checked and adjusted; therefore, further measurement accuracy checks may not be necessary for the instruments intended use.*

a. Set mA pushbutton in.

b. Connect the AC Calibration Standard (Current configuration) to the mA-Ω and common jacks using two banana-plug to BNC adapters and a cable.

c. Set VOLTS-mA/DIV and the Standard as shown in Table 6-11.

CHECK—Reading is within limits shown in Table 6-11.

e. Disconnect Standard.

TABLE 6-11
RMS Current Measurement Accuracy

| VOLTS-mA/DIV Setting (blue scale) | AC Calibration Standard Setting (set at 40 kHz) | Reading | Limits |
|---|---|---|---|
| 0.1 | 0.200 mA | 0.200 | .1950 to .2050 |
| 1 | 2.00 mA | 2.000 | 1.925 to 2.075 |
| 10 | 20.00 mA | 20.00 | 19.25 to 20.75 |
| 100 | 200.0 mA | 200.0 | 192.5 to 207.5 |
| 1000 | 1000 mA | 1000 | 0925 to 1075 |

**END OF PROCEDURE**

# INSTRUMENT OPTIONS

Your instrument may be equipped with the following option, if it was ordered from the factory with the option installed. If not, the option can be installed at a later date by contacting the closest Tektronix Field Office or representative.

## OPTION 1

This option allows the instrument to charge the batteries or operate from a power line source of 180 to 250 V ac (48 to 62 Hz) or 180 to 250 V dc. Refer to the parts list and Diagram 5 in this manual for information concerning C416 which is used with Option 1 but not with the standard 213. Refer to Accessories page at the back of the manual for the power cord cable assembly included with Option 1 for adapting to appropriate power plugs. Part number for the A5 board used with Option 1 is listed here.

| | | |
|---|---|---|
| A5 | 670-2226-21 | CIRCUIT BOARD ASSEMBLY: POWER SUPPLY (OPTION 1) |

# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

| | |
|---|---|
| X000 | Part first added at this serial number |
| 00X | Part removed after this serial number |

### ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

| | | | |
|---|---|---|---|
| ACTR | ACTUATOR | PLSTC | PLASTIC |
| ASSY | ASSEMBLY | QTZ | QUARTZ |
| CAP | CAPACITOR | RECP | RECEPTACLE |
| CER | CERAMIC | RES | RESISTOR |
| CKT | CIRCUIT | RF | RADIO FREQUENCY |
| COMP | COMPOSITION | SEL | SELECTED |
| CONN | CONNECTOR | SEMICOND | SEMICONDUCTOR |
| ELCTLT | ELECTROLYTIC | SENS | SENSITIVE |
| ELEC | ELECTRICAL | VAR | VARIABLE |
| INCAND | INCANDESCENT | WW | WIREWOUND |
| LED | LIGHT EMITTING DIODE | XFMR | TRANSFORMER |
| NONWIR | NON WIREWOUND | XTAL | CRYSTAL |

## CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|---|---|---|---|
| 00213 | NYTRONICS COMPONENTS GROUP INC<br>SUBSIDIARY OF NYTRONICS INC | ORANGE ST | DARLINGTON SC 29532 |
| 00853 | SANGAMO WESTON INC<br>COMPONENTS DIV | SANGAMO RD<br>PO BOX 128 | PICKENS SC 29671-9716 |
| 01121 | ALLEN-BRADLEY CO | 1201 S 2ND ST | MILWAUKEE WI 53204-2410 |
| 01295 | TEXAS INSTRUMENTS INC<br>SEMICONDUCTOR GROUP | 13500 N CENTRAL EXPY<br>PO BOX 655012 | DALLAS TX 75265 |
| 02111 | HAMILTON STANDARD CONTROLS INC<br>SPECTROL DIV | 17070 E GALE AVE<br>P O BOX 1220 | CITY OF INDUSTRY CA 91749 |
| 02735 | RCA CORP<br>SOLID STATE DIVISION | ROUTE 202 | SOMERVILLE NJ 08876 |
| 03508 | GENERAL ELECTRIC CO<br>SEMI-CONDUCTOR PRODUCTS DEPT | W GENESEE ST | AUBURN NY 13021 |
| 03888 | PYROFILM DIV<br>DIV OF KDI ELECTRONICS INC | 60 S JEFFERSON RD | WHIPPANY NJ 07981-1001 |
| 04072 | BELL INDUSTRIES<br>JW MILLER DIVISION | | COMPTON CA 94539 |
| 04222 | AVX CERAMICS<br>DIV OF AVX CORP | 19TH AVE SOUTH<br>P O BOX 867 | MYRTLE BEACH SC 29577 |
| 04713 | MOTOROLA INC<br>SEMICONDUCTOR PRODUCTS SECTOR | 5005 E MCDOWELL RD | PHOENIX AZ 85008-4229 |
| 05397 | UNION CARBIDE CORP<br>MATERIALS SYSTEMS DIV | 11901 MADISON AVE | CLEVELAND OH 44101 |
| 07263 | FAIRCHILD SEMICONDUCTOR CORP<br>NORTH AMERICAN SALES<br>SUB OF SCHLUMBERGER LTD MS 118 | 10400 RIDGEVIEW CT | CUPERTINO CA 95014 |
| 07716 | TRW INC<br>TRW IRC FIXED RESISTORS/BURLINGTON | 2850 MT PLEASANT AVE | BURLINGTON IA 52601 |
| 08806 | GENERAL ELECTRIC CO<br>MINIATURE LAMP PRODUCTS DEPT<br>LIGHTING BUSINESS GROUP | NELA PK | CLEVELAND OH 44112 |
| 12969 | UNITRODE CORP | 5 FORBES RD | LEXINGTON MA 02173-7305 |
| 14433 | ITT SEMICONDUCTORS DIV | | WEST PALM BEACH FL |
| 14552 | MICROSEMI CORP | 2830 S FAIRVIEW ST | SANTA ANA CA 92704-5948 |
| 14752 | ELECTRO CUBE INC | 1710 S DEL MAR AVE | SAN GABRIEL CA 91776-3825 |
| 14936 | GENERAL INSTRUMENT CORP<br>DISCRETE SEMI CONDUCTOR DIV | 600 W JOHN ST | HICKSVILLE NY 11802 |
| 19396 | ILLINOIS TOOL WORKS INC<br>PAKTRON DIV | 1205 MCCONVILLE RD<br>PO BOX 4539 | LYNCHBURG VA 24502-4535 |
| 19701 | MEPCO/CENTRALAB<br>A NORTH AMERICAN PHILIPS CO<br>MINERAL WELLS AIRPORT | PO BOX 760 | MINERAL WELLS TX 76067-0760 |
| 22229 | SOLITRON DEVICES INC<br>SEMICONDUCTOR GROUP SAN DIEGO OPERS | 8808 BALBOA AVE | SAN DIEGO CA 92123 |
| 24546 | CORNING GLASS WORKS | 550 HIGH ST | BRADFORD PA 16701-3737 |
| 27014 | NATIONAL SEMICONDUCTOR CORP | 2900 SEMICONDUCTOR DR | SANTA CLARA CA 95051-0606 |
| 32293 | INTERSIL INC<br>SUB OF GENERAL ELECTRIC CO | 10600 RIDGEVIEW COURT | CUPERTINO CA 95014-0704 |
| 32997 | BOURNS INC<br>TRIMPOT DIV | 1200 COLUMBIA AVE | RIVERSIDE CA 92507-2114 |
| 50434 | HEWLETT-PACKARD CO<br>OPTOELECTRONICS DIV | 370 W TRIMBLE RD | SAN JOSE CA 95131 |
| 51406 | MURATA ERIE NORTH AMERICA INC<br>HEADQUARTERS AND GEORGIA OPERATIONS | 2200 LAKE PARK DR | SMYRNA GA 30080 |
| 51642 | CENTRE ENGINEERING INC | 2820 E COLLEGE AVE | STATE COLLEGE PA 16801-7515 |
| 52763 | STETCO INC | 3344 SCHIERHORN | FRANKLIN PARK IL 60131 |
| 56289 | SPRAGUE ELECTRIC CO<br>WORLD HEADQUARTERS | 92 HAYDEN AVE | LEXINGTON MA 02173-7929 |
| 57668 | ROHM CORP | 8 WHATNEY<br>PO BOX 19515 | IRVINE CA 92713 |
| 59660 | TUSONIX INC | 7741 N BUSINESS PARK DR<br>PO BOX 37144 | TUCSON AZ 85740-7144 |
| 59821 | MEPCO/CENTRALAB<br>A NORTH AMERICAN PHILIPS CO | 7158 MERCHANT AVE | EL PASO TX 79915-1207 |
| 60496 | MICREL INC | 1235 MIDAS WAY | SUNNYVALE CA 94086-4021 |
| 66844 | POWEREX INC | HILLIS ST | YOUNGWOOD PA 15697 |

# CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|---|---|---|---|
| 71590 | CRL COMPONENTS INC | HWY 20 W<br>PO BOX 858 | FORT DODGE IA 50501 |
| 73138 | BECKMAN INDUSTRIAL CORP<br>BECKMAN ELECTRONIC TECHNOLOGIES<br>SUB OF EMERSON ELECTRIC | 4141 PALM ST | FULLERTON CA 92635 |
| 75042 | IRC ELECTRONIC COMPONENTS<br>PHILADELPHIA DIV<br>TRW FIXED RESISTORS | 401 N BROAD ST | PHILADELPHIA PA 19108-1001 |
| 75498 | MULTICOMP INC | 3005 SW 154TH TERRACE #3 | BEAVERTON OR 97006 |
| 75915 | LITTELFUSE INC<br>SUB TRACOR INC | 800 E NORTHWEST HWY | DES PLAINES IL 60016-3049 |
| 79727 | C-W INDUSTRIES | 130 JAMES WAY | SOUTHAMPTON PA 18966-3818 |
| 80009 | TEKTRONIX INC | 14150 SW KARL BRAUN DR<br>PO BOX 500 | BEAVERTON OR 97077-0001 |
| 80031 | MEPCO/ELECTRA INC | 22 COLUMBIA RD | MORRISTOWN NJ 07960 |
| 91637 | DALE ELECTRONICS INC | 2064 12TH AVE<br>PO BOX 609 | COLUMBUS NE 68601-3632 |
| TK2278 | COMTEK MANUFACTURING OF OREGON (METALS) | PO BOX 4200 | BEAVERTON OR 97076-4200 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| A1 | 670-2225-00 | | | CIRCUIT BD ASSY:ATTENUATOR | 80009 | 670-2225-00 |
| A2 | 670-2224-00 | B010100 | B039999 | CIRCUIT BD ASSY:FUNCTION | 80009 | 670-2224-00 |
| A2 | 670-2224-01 | B040000 | B046248 | CIRCUIT BD ASSY:FUNCTION | 80009 | 670-2224-01 |
| A2 | 670-2224-02 | B046249 | B046625 | CIRCUIT BD ASSY:FUNCTION | 80009 | 670-2224-02 |
| A2 | 670-2224-03 | B046626 | | CIRCUIT BD ASSY:FUNCTION | 80009 | 670-2224-03 |
| A3 | 670-2227-00 | B010100 | B029999 | CIRCUIT BD ASSY:A-D CONVERTER | 80009 | 670-2227-00 |
| A3 | 670-2227-01 | B030000 | B039999 | CIRCUIT BD ASSY:A-D CONVERTER | 80009 | 670-2227-01 |
| A3 | 670-2227-02 | B040000 | B046156 | CIRCUIT BD ASSY:A-D CONVERTER | 80009 | 670-2227-02 |
| A3 | 670-2227-03 | B046157 | | CIRCUIT BD ASSY:A-D CONVERTER | 80009 | 670-2227-03 |
| A3 | 670-2227-05 | B046249 | | CIRCUIT BD ASSY:A-D CONVERTOR | 80009 | 670-2227-05 |
| A4 | 670-2228-00 | B010100 | B029999 | CIRCUIT BD ASSY:OUTPUT AMPLIFIER | 80009 | 670-2228-00 |
| A4 | 670-2228-01 | B030000 | B031382 | CIRCUIT BD ASSY:AMPLIFIER | 80009 | 670-2228-01 |
| A4 | 670-2228-02 | B031383 | B042749 | CIRCUIT BD ASSY:AMPLIFIER | 80009 | 670-2228-02 |
| A4 | 670-2228-03 | B042750 | B046248 | CIRCUIT BD ASSY:AMPLIFIER | 80009 | 670-2228-03 |
| A4 | 670-2228-04 | B046249 | | CIRCUIT BD ASSY:AMPLIFIER | 80009 | 670-2228-04 |
| A5 | 670-2226-00 | B010100 | B029999 | CIRCUIT BD ASSY: | 80009 | 670-2226-00 |
| A5 | 670-2226-01 | B030000 | B046248 | CIRCUIT BD ASSY:POWER SUPPLY | 80009 | 670-2226-01 |
| A5 | 670-2226-02 | B046249 | | CIRCUIT BD ASSY:POWER SUPPLY | 80009 | 670-2226-02 |
| A6 | 670-2608-00 | B010100 | B040310 | CIRCUIT BD ASSY:POWER SUPPLY | 80009 | 670-2608-00 |
| A6 | 672-0414-00 | B010100 | B047085 | CIRCUIT BD ASSY:LINE CONN (LATER BOARDS AVAILABLE ONLY AT 672 LEVEL) | 80009 | 672-0414-00 |
| A6 | 672-0414-01 | B047086 | B047209 | CIRCUIT BD ASSY:POWER SUPPLY | 80009 | 672-0414-01 |
| A6 | 672-0414-02 | B047210 | | CIRCUIT BD ASSY:PWR SPLY | 80009 | 672-0414-02 |
| BT444 | 146-0032-00 | | | BATTERY,STORAGE:2.4V,4AH @ 350MA,(2)D CELL, NICAD | 80009 | 146-0032-00 |
| C101 | 285-0997-00 | | | CAP,FXD,PLASTIC:0.02,10%,1KV | 80009 | 285-0997-00 |
| C103 | 283-0260-00 | | | CAP,FXD,CER DI:5.6PF,+/-0.25PF,200V | 51642 | 150 200NP0569C |
| C104 | 281-0182-00 | | | CAP,VAR,PLASTIC:1.8-10PF,300V | 19701 | 2805D1R810BH03F0 |
| C106 | 283-0669-00 | | | CAP,FXD,MICA DI:360PF,1%,500V | 00853 | D155F361F0 |
| C108 | 281-0178-00 | | | CAP,VAR,PLASTIC:1-3.5PF,500V | 80031 | 2805D013R5BH02F0 |
| C109 | 283-0615-00 | | | CAP,FXD,MICA DI:33PF,5%,500V | 00853 | D155E330J0 |
| C110 | 283-0185-00 | | | CAP,FXD,CER DI:2.5PF,0.5%,50V | 51642 | 100-050-NP0-259B |
| C111 | 281-0613-00 | | | CAP,FXD,CER DI:10PF,1%,500V | 59660 | 374-018C0G0100F |
| C112 | 281-0220-00 | | | CAP,VAR,CER DI:1.0-5.5PF,400VDC,PC MTG | 52763 | 313613210 |
| C136 | 290-0524-00 | | | CAP,FXD,ELCTLT:4.7UF,20%,10V | 05397 | T368A475M010AZ |
| C137 | 290-0524-00 | | | CAP,FXD,ELCTLT:4.7UF,20%,10V | 05397 | T368A475M010AZ |
| C140 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C142 | 283-0000-00 | | | CAP,FXD,CER DI:0.001UF,+100-0%,500V | 59660 | 831-610-Y5U0102P |
| C143 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C144 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C145 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C146 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C150 | 283-0175-00 | | | CAP,FXD,CER DI:10PF,5%,200V | 05397 | C312C100D2G5CA 8 |
| C154 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C165 | 283-0000-00 | | | CAP,FXD,CER DI:0.001UF,+100-0%,500V | 59660 | 831-610-Y5U0102P |
| C174 | 281-0572-00 | | | CAP,FXD,CER DI:6.8PF,0.5%,500V | 52763 | 2RDPLZ007 6P80DC |
| C176 | 285-1096-00 | | | CAP,FXD,PLASTIC:1UF,10%,50V | 14752 | 230B1A105K |
| C178 | 285-1097-00 | | | CAP,FXD,PLASTIC:0.47UF,10%,50V | 14752 | 230B1A474K |
| C179 | 283-0000-00 | B010100 | B046625 | CAP,FXD,CER DI:0.001UF,+100-0%,500V | 59660 | 831-610-Y5U0102P |
| C179 | 283-0204-00 | B046626 | | CAP,FXD,CER DI:0.01UF,20%,50V | 04222 | SR155E103MAA |
| C180 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C181 | 283-0094-00 | | | CAP,FXD,CER DI:27PF,10%,200V | 59821 | 2DDT73K270K |
| C182 | ----- ----- | | | (PART OF CIRCUIT BOARD) | | |
| C183 | 283-0204-00 | | | CAP,FXD,CER DI:0.01UF,20%,50V | 04222 | SR155E103MAA |
| C184 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C185 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C186 | 283-0299-00 | | | CAP,FXD,CER DI:51PF,5%,500V | 04222 | SR157A510JAA |
| C187 | ----- ----- | | | (PART OF CIRCUIT BOARD) | | |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| C188 | 283-0094-00 | | | CAP,FXD,CER DI:27PF,10%,200V | 59821 | 2DDT73K270K |
| C189 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C190 | 290-0135-00 | | | CAP,FXD,ELCTLT:15UF,20%,20V | 05397 | T110B156M020AS |
| C222 | 283-0177-00 | | | CAP,FXD,CER DI:1UF,+80-20%,25V | 04222 | SR305E105ZAA |
| C227 | 285-0934-00 | B010100 | B039999 | CAP,FXD,PLASTIC:2.2UF,10%,200V | 80009 | 285-0934-00 |
| C227 | 285-0894-00 | B040000 | | CAP,FXD,PLASTIC:5UF,5%,50V | 14752 | A650DIA505J |
| C237 | 283-0111-00 | | | CAP,FXD,CER DI:0.1UF,20%,50V | 04222 | SR305C104MAA |
| C238 | 283-0111-00 | | | CAP,FXD,CER DI:0.1UF,20%,50V | 04222 | SR305C104MAA |
| C245 | 283-0605-00 | | | CAP,FXD,MICA DI:678PF,1%,300V | 00853 | D153F6780F0 |
| C255 | 281-0546-00 | | | CAP,FXD,CER DI:330PF,10%,500V | 52763 | 2RDPLZ007 330PM0 |
| C258 | 281-0546-00 | | | CAP,FXD,CER DI:330PF,10%,500V | 52763 | 2RDPLZ007 330PM0 |
| C261 | 283-0001-00 | | | CAP,FXD,CER DI:0.005UF,+100-0%,500V | 59821 | 2DDH61L502P |
| C263 | 283-0001-00 | | | CAP,FXD,CER DI:0.005UF,+100-0%,500V | 59821 | 2DDH61L502P |
| C268 | 283-0023-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,12V | 71590 | 2DDU66B104Z |
| C270 | 283-0003-00 | | | CAP,FXD,CER DI:0.01UF,+80-20%,150V | 59821 | D103Z40Z5UJDCEX |
| C280 | 283-0023-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,12V | 71590 | 2DDU66B104Z |
| C282 | 283-0111-00 | | | CAP,FXD,CER DI:0.1UF,20%,50V | 04222 | SR305C104MAA |
| C284 | 283-0203-00 | | | CAP,FXD,CER DI:0.47UF,20%,50V | 04222 | SR305SC474MAA |
| C314 | 283-0663-00 | | | CAP,FXD,MICA DI:16.8PF,+/0.5PF,500V | 00853 | D155C16R8D0 |
| C315 | 281-0524-00 | | | CAP,FXD,CER DI:150PF,+/-30PF,500V | 52763 | 2RDPLZ007 150PM0 |
| C316 | 283-0024-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,50V | 04222 | SR215C104MAA |
| C322 | 290-0535-00 | | | CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM | 56289 | 196D336X0010KA1 |
| C323 | 290-0535-00 | | | CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM | 56289 | 196D336X0010KA1 |
| C325 | 295-0158-00 | | | CAP SET,MATCHED:1UF,0.001UF,MATCHED 2% | 80009 | 295-0158-00 |
| C326 | ----- ----- | | | (PART OF C235,INDIVIDUAL TIMING CAPACITORS MUST BE ORDERED BY THEIR 9-DIGIT PART NUMBER.THE LETTER SUFFIX AND TOLERANCE PRINTED ON EACH TIMING CAPACITOR SHOULD BE THE SAME FOR ALL THOSE USED IN A MATCHED SET.EXAMPLE: 285-XXXX-XX F -) | | |
| C327 | 283-0000-00 | | | CAP,FXD,CER DI:0.001UF,+100-0%,500V | 59660 | 831-610-Y5U0102P |
| C328 | 290-0283-00 | | | CAP,FXD,ELCTLT:0.47UF,10%,35V | 05397 | T320A474K035AS |
| C329 | 283-0003-00 | | | CAP,FXD,CER DI:0.01UF,+80-20%,150V | 59821 | D103Z40Z5UJDCEX |
| C331 | 283-0149-00 | | | CAP,FXD,CER DI:25PF,2%,200V | 59660 | 865-528T2H250G |
| C333 | 283-0080-00 | | | CAP,FXD,CER DI:0.022UF,+80-20%,25V | 59821 | 2DDU60E223Z |
| C334 | 290-0534-00 | | | CAP,FXD,ELCTLT:1UF,20%,35V | 05397 | T368A105M035AZ |
| C335 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C336 | 283-0003-00 | | | CAP,FXD,CER DI:0.01UF,+80-20%,150V | 59821 | D103Z40Z5UJDCEX |
| C337 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C338 | 283-0251-00 | B042750 | | CAP,FXD,CER DI:87 PF,5%,100V | 04222 | 3418 100A 870J |
| C363 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C372 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C375 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C376 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C412 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C413 | 283-0279-00 | | | CAP,FXD,CER DI:0.001UF,20%,3000V | 51406 | DHR12Y5S102M3KV |
| C414 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C415 | 283-0279-00 | | | CAP,FXD,CER DI:0.001UF,20%,3000V | 51406 | DHR12Y5S102M3KV |
| C416 | 283-0005-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,250V (OPTION 1 ONLY) | 04222 | SR303E103ZAA |
| C417 | 290-0414-00 | | | CAP,FXD,ELCTLT:8UF,+50-10%,200V | 56289 | 600D805F200DE4 |
| C418 | 290-0414-00 | | | CAP,FXD,ELCTLT:8UF,+50-10%,200V | 56289 | 600D805F200DE4 |
| C422 | 283-0008-00 | | | CAP,FXD,CER DI:0.1UF,20%,500V | 04222 | SR507C104MAA |
| C423 | 283-0330-00 | | | CAP,FXD,CER DI:100PF,5%,50V | 05397 | C320C101J5R5CA |
| C425 | 283-0180-00 | B010100 | B047209 | CAP,FXD,CER DI:5600PF,20%,200V | 04222 | 3429 200E 562M |
| C425 | 283-0204-00 | B047210 | | CAP,FXD,CER DI:0.01UF,20%,50V | 04222 | SR155E103MAA |
| C427 | 285-1095-00 | | | CAP,FXD,PLASTIC:0.0033UF,10%,600V | 19396 | 332K06PP481 |
| C436 | ----- ----- | | | (PART OF A7) | | |
| C440 | 290-0535-00 | | | CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM | 56289 | 196D336X0010KA1 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| C442 | 283-0023-00 | | | CAP,FXD,CER DI:0.1UF,+80-20%,12V | 71590 | 2DDU66B104Z |
| C446 | 290-0723-00 | | | CAP,FXD,ELCTLT:150UF,20%,6V | 56289 | 196D157X0006PE3 |
| C451 | 283-0080-00 | | | CAP,FXD,CER DI:0.022UF,+80-20%,25V | 59821 | 2DDU60E223Z |
| C456 | 290-0524-00 | | | CAP,FXD,ELCTLT:4.7UF,20%,10V | 05397 | T368A475M010AZ |
| C460 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C466 | 290-0523-00 | | | CAP,FXD,ELCTLT:2.2UF,20%,20V | 05397 | T368A225M020AS |
| C470 | 283-0032-00 | | | CAP,FXD,CER DI:470PF,5%,500V | 59660 | 831-000-Z5E0471J |
| C472 | 283-0080-00 | | | CAP,FXD,CER DI:0.022UF,+80-20%,25V | 59821 | 2DDU60E223Z |
| C474 | 290-0282-00 | | | CAP,FXD,ELCTLT:0.047UF,10%,35V | 05397 | T320A473K035AS |
| C475 | 283-0669-00 | | | CAP,FXD,MICA DI:360PF,1%,500V | 00853 | D155F361F0 |
| C505 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C506 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C508 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C511 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C512 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C513 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C514 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C515 | 285-1069-00 | | | CAP,FXD,PLASTIC:0.047UF,20%,200V | 14752 | C2319 |
| C516 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C517 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C518 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C519 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C520 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C521 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C522 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C523 | 283-0068-00 | | | CAP,FXD,CER DI:0.01UF,+100-0%,500V | 59660 | 871-533E103P |
| C524 | 283-0187-00 | | | CAP,FXD,CER DI:0.047UF,10%,400V | 04222 | SR308C473KAA |
| C525 | 283-0103-00 | | | CAP,FXD,CER DI:180PF,5%,500V | 59821 | 2DDH73L181J |
| C526 | 283-0114-00 | | | CAP,FXD,CER DI:1500PF,5%,200V | 59660 | 805-534-Y5D0152J |
| C530 | 283-0013-00 | | | CAP,FXD,CER DI:0.01UF,-0+100%,1000V | 59660 | 818-602ZSU0103P |
| C532 | 283-0001-00 | | | CAP,FXD,CER DI:0.005UF,+100-0%,500V | 59821 | 2DDH61L502P |
| C534 | 283-0003-00 | | | CAP,FXD,CER DI:0.01UF,+80-20%,150V | 59821 | D103Z40Z5UJDCEX |
| C540 | 290-0164-00 | | | CAP,FXD,ELCTLT:1UF,+50-10%,150V | 56289 | 500D105F150BA2R2 |
| C543 | 290-0527-00 | | | CAP,FXD,ELCTLT:15UF,20%,20V | 05397 | T368B156M020AS |
| C544 | 290-0720-00 | | | CAP,FXD,ELCTLT:68UF,20%,15V | 56289 | 196D686X0015PE3 |
| C545 | 290-0527-00 | | | CAP,FXD,ELCTLT:15UF,20%,20V | 05397 | T368B156M020AS |
| C547 | 290-0527-00 | | | CAP,FXD,ELCTLT:15UF,20%,20V | 05397 | T368B156M020AS |
| C550 | 290-0535-00 | | | CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM | 56289 | 196D336X0010KA1 |
| C552 | 290-0535-00 | | | CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM | 56289 | 196D336X0010KA1 |
| C554 | 290-0535-00 | | | CAP,FXD,ELCTLT:33UF,20%,10V TANTALUM | 56289 | 196D336X0010KA1 |
| C555 | 290-0722-00 | | | CAP,FXD,ELCTLT:100 UF,20%,10V | 56289 | 196D107X0010PE3 |
| C556 | 290-0722-00 | | | CAP,FXD,ELCTLT:100 UF,20%,10V | 56289 | 196D107X0010PE3 |
| C590 | 290-0194-00 | | | CAP,FXD,ELCTLT:10UF,+50-10%,100V | 00853 | 556DC100T100B |
| CR118 | 152-0198-02 | | | SEMICOND DVC,DI:RECT,SI,200V,3A,A249G | 80009 | 152-0198-02 |
| CR119 | 152-0198-02 | | | SEMICOND DVC,DI:RECT,SI,200V,3A,A249G | 80009 | 152-0198-02 |
| CR120 | 152-0198-02 | | | SEMICOND DVC,DI:RECT,SI,200V,3A,A249G | 80009 | 152-0198-02 |
| CR121 | 152-0198-02 | | | SEMICOND DVC,DI:RECT,SI,200V,3A,A249G | 80009 | 152-0198-02 |
| CR140 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR142 | 153-0057-00 | B010100 | B046625 | SEMICOND DVC,DI:SELECTED | 80009 | 153-0057-00 |
| CR142 | 152-0324-00 | B046626 | | SEMICOND DVC,DI:SW,SI,35V,0.1A,DO-7 | 14552 | MT5128 |
| CR143 | 153-0057-00 | B010100 | B046625 | SEMICOND DVC,DI:SELECTED | 80009 | 153-0057-00 |
| CR143 | 152-0324-00 | B046626 | | SEMICOND DVC,DI:SW,SI,35V,0.1A,DO-7 | 14552 | MT5128 |
| CR147 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR154 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR155 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR156 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR157 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR158 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| CR159 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR182 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR183 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR184 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR185 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR187 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR188 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR189 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR190 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR197 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR199 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR206 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR217 | 152-0151-00 | | | SEMICOND DVC,DI:SW,SI | 80009 | 152-0151-00 |
| CR230 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR261 | 152-0322-00 | | | SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35 | 50434 | 5082-2672 |
| CR263 | 152-0322-00 | | | SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35 | 50434 | 5082-2672 |
| CR268 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR326 | 152-0246-00 | | | SEMICOND DVC,DI:SW,SI,40V,200MA,DO-7 | 14433 | WG1537TK |
| CR332 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR333 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR345 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR350 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR355 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR360 | 152-0574-00 | | | SEMICOND DVC,DI:SW,SI,120V,0.150MA,4NS,DO35 | 12969 | NDP566 |
| CR365 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR369 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR371 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR374 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR391 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR392 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR393 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR394 | 152-0574-00 | B010100 | B031382 | SEMICOND DVC,DI:SW,SI,120V,0.150MA,4NS,DO35 | 12969 | NDP566 |
| CR395 | 152-0574-00 | | | SEMICOND DVC,DI:SW,SI,120V,0.150MA,4NS,DO35 | 12969 | NDP566 |
| CR412 | 152-0107-00 | | | SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1 | 12969 | "G727" |
| CR413 | 152-0107-00 | | | SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1 | 12969 | "G727" |
| CR414 | 152-0107-00 | | | SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1 | 12969 | "G727" |
| CR415 | 152-0107-00 | | | SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1 | 12969 | "G727" |
| CR421 | 152-0107-04 | | | SEMICOND DVC,DI:RECT,SI,400V,400MA | 14936 | GPD-011 |
| CR422 | 152-0400-00 | | | SEMICOND DVC,DI:RECT,SI,400V,1A | 04713 | 1N4936RL |
| CR423 | 152-0107-04 | | | SEMICOND DVC,DI:RECT,SI,400V,400MA | 14936 | GPD-011 |
| CR424 | 152-0400-00 | | | SEMICOND DVC,DI:RECT,SI,400V,1A | 04713 | 1N4936RL |
| CR425 | 152-0107-00 | | | SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1 | 12969 | "G727" |
| CR426 | 152-0401-00 | B010100 | B047085 | SEMICOND DVC,DI:SCHOTTKY,SI,32V,2A,TO-92 | 04713 | SPT32K |
| CR426 | 152-0959-00 | B047086 | | SEMICOND DVC,DI:DIAC,SI,BI DIRECTIONAL 32V/ 200UA | 66844 | GE ST2 |
| CR427 | 152-0400-00 | | | SEMICOND DVC,DI:RECT,SI,400V,1A | 04713 | 1N4936RL |
| CR428 | 152-0400-00 | | | SEMICOND DVC,DI:RECT,SI,400V,1A | 04713 | 1N4936RL |
| CR430 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR432 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR434 | ----- ----- | | | (PART OF A7) | | |
| CR435 | ----- ----- | | | (PART OF A7) | | |
| CR445 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR446 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR450 | 150-1004-00 | B010100 | B032027 | LT EMITTING DIO:RED,15MA | 08806 | SSL-12 |
| CR450 | 150-1031-03 | B032028 | | LT EMITTING DIO:RED,650NM,40MA MAX W/WIRE & CONN | 80009 | 150-1031-03 |
| CR451 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR454 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| CR472 | 152-0141-02 | | | SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 | 03508 | DA2527 (1N4152) |
| CR505 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR506 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR508 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR511 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR512 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR513 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR514 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR515 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR516 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR517 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR518 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR519 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR520 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR521 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR522 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR523 | 152-0242-00 | | | SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7 | 07263 | FDH5004 |
| CR540 | 152-0061-00 | | | SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35 | 07263 | FDH2161 |
| CR542 | 152-0061-00 | | | SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35 | 07263 | FDH2161 |
| CR543 | 152-0581-00 | | | SEMICOND DVC,DI:RECT,SI,20V,1A,A59 | 04713 | 1N5817 |
| CR544 | 152-0581-00 | | | SEMICOND DVC,DI:RECT,SI,20V,1A,A59 | 04713 | 1N5817 |
| CR550 | 152-0333-00 | | | SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35 | 07263 | FDH-6012 |
| CR552 | 152-0581-00 | | | SEMICOND DVC,DI:RECT,SI,20V,1A,A59 | 04713 | 1N5817 |
| CR554 | 152-0581-00 | | | SEMICOND DVC,DI:RECT,SI,20V,1A,A59 | 04713 | 1N5817 |
| F161 | 159-0124-00 | | | FUSE,WIRE LEAD:3A,125V,0.05SEC | 75915 | 272003 |
| F410 | 159-0080-00 | | | FUSE,CARTRIDGE:DIN,0.2A,250V,10SEC | 75915 | 218.200 |
| J120 | 129-0397-01 | | | POST,CONTACT:.940 OA LG;CD PL BR | TK2278 | ORDER BY DESCR |
| J125 | 129-0397-00 | | | POST,CONTACT:TIP JACK,CKT BD MTG | TK2278 | ORDER BY DESCR |
| J315 | 129-0397-00 | | | POST,CONTACT:TIP JACK,CKT BD MTG | TK2278 | ORDER BY DESCR |
| L322 | 108-0395-00 | | | COIL,RF:FIXED,64UH | 80009 | 108-0395-00 |
| L324 | 108-0395-00 | | | COIL,RF:FIXED,64UH | 80009 | 108-0395-00 |
| L340 | 108-0800-00 | | | COIL,RF:FIXED,820MH | 04072 | 9230-90 |
| L344 | 108-0800-00 | | | COIL,RF:FIXED,820MH | 04072 | 9230-90 |
| L417 | 108-0231-00 | | | COIL,RF:FIXED,4.5UH | 80009 | 108-0231-00 |
| L418 | 108-0231-00 | | | COIL,RF:FIXED,4.5UH | 80009 | 108-0231-00 |
| L435 | ----- ----- | | | (PART OF A7) | | |
| L500 | ----- ----- | | | COIL,TUBE DEFL:TRACE ROTATION (L500, FURNISHED AS A UNIT WITH V560, NOT INDIVIDUALLY REPLACEABLE.) | | |
| L537 | 108-0056-00 | | | COIL,RF:FIXED,1.06UH | 80009 | 108-0056-00 |
| L543 | 108-0395-00 | | | COIL,RF:FIXED,64UH | 80009 | 108-0395-00 |
| L550 | 108-0395-00 | | | COIL,RF:FIXED,64UH | 80009 | 108-0395-00 |
| L554 | 108-0395-00 | | | COIL,RF:FIXED,64UH | 80009 | 108-0395-00 |
| P100 | 175-1255-00 | | | CABLE,RF:50 OHM COAX,WHITE VINYL JKT | 80009 | 175-1255-00 |
| Q140 | 151-0354-00 | | | TRANSISTOR:PNP,SI,DUAL,TO-78 | 32293 | ITS-1200-A |
| Q142 | 151-0192-00 | | | TRANSISTOR:NPN,SI,TO-92 | 04713 | SPS8801 |
| Q144 | 151-0192-00 | | | TRANSISTOR:NPN,SI,TO-92 | 04713 | SPS8801 |
| Q145 | 151-1047-00 | | | TRANSISTOR:FET,N-CHAN,SI | 22229 | FD1623 |
| Q146 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q150 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q154 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q155 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q156 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q158 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q159 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q162 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q170 | 153-0629-00 | | | SEMICOND DVC SE:MTCHD PAIR | 80009 | 153-0629-00 |
| Q172 | ----- ----- | | | (PART OF Q170) | | |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| Q174 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q180 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q182 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q185 | 153-0621-00 | | | SEMICOND DVC SE:MTCHED PAIR | 80009 | 153-0621-00 |
| Q188 | ----- ----- | | | (PART OF Q185) | | |
| Q190 | 151-0354-00 | | | TRANSISTOR:PNP,SI,DUAL,TO-78 | 32293 | ITS-1200-A |
| Q192 | 151-0353-00 | B010100 | B046625 | TRANSISTOR:NPN,SI,DUAL,TO-78 | 80009 | 151-0353-00 |
| Q192 | 151-0619-00 | B046626 | | TRANSISTOR:NPN,DUAL,SIX LEAD,TO-5 | 27014 | SL41341 |
| Q194 | 151-0353-00 | | | TRANSISTOR:NPN,SI,DUAL,TO-78 | 80009 | 151-0353-00 |
| Q195 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q196 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q198 | 151-0353-00 | | | TRANSISTOR:NPN,SI,DUAL,TO-78 | 80009 | 151-0353-00 |
| Q204 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q206 | 151-0342-00 | | | TRANSISTOR:PNP,SI,TO-92 | 07263 | S035928 |
| Q214 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q215 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q230 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q240 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q245 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q247 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q254 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q256 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q258 | 151-0342-00 | | | TRANSISTOR:PNP,SI,TO-92 | 07263 | S035928 |
| Q260 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q262 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q264 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q266 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q275 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q278 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q280 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q335 | 151-0410-00 | B010100 | B010359 | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q340 | 151-0432-00 | | | TRANSISTOR:NPN,SI,625MW,TO-92 | 04713 | SPS8512 |
| Q345 | 151-0432-00 | | | TRANSISTOR:NPN,SI,625MW,TO-92 | 04713 | SPS8512 |
| Q346 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q347 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q348 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q350 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q355 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q360 | 151-0432-00 | | | TRANSISTOR:NPN,SI,625MW,TO-92 | 04713 | SPS8512 |
| Q364 | 151-0432-00 | | | TRANSISTOR:NPN,SI,625MW,TO-92 | 04713 | SPS8512 |
| Q366 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q368 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q370 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q374 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q380 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q385 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q390 | 151-0190-00 | B010100 | B031382 | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q390 | 151-0432-00 | B031383 | | TRANSISTOR:NPN,SI,625MW,TO-92 | 04713 | SPS8512 |
| Q394 | 151-0432-00 | B010100 | B031382 | TRANSISTOR:NPN,SI,625MW,TO-92 | 04713 | SPS8512 |
| Q422 | 151-0358-00 | | | TRANSISTOR:SELECTED | 80009 | 151-0358-00 |
| Q424 | 151-0358-00 | | | TRANSISTOR:SELECTED | 80009 | 151-0358-00 |
| Q442 | 151-0456-00 | B010100 | B031221 | TRANSISTOR:NPN,SI,TO-92 | 07263 | S39988 |
| Q442 | 151-0192-00 | B031222 | | TRANSISTOR:NPN,SI,TO-92 | 04713 | SPS8801 |
| Q444 | 153-0642-00 | B010100 | B029999 | TRANSISTOR:SELECTED | 80009 | 153-0642-00 |
| Q444 | 151-0261-00 | B030000 | | TRANSISTOR:PNP,SI,TO-77 | 80009 | 151-0261-00 |
| Q458 | 151-0503-00 | | | SCR:SI,TO-92 | 04713 | SCR5138 |
| Q460 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |
| Q465 | 151-0341-00 | | | TRANSISTOR:NPN,SI,TO-106 | 04713 | SPS6919 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| Q470 | 151-0192-00 | | | TRANSISTOR:NPN,SI,TO-92 | 04713 | SPS8801 |
| Q474 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| Q475 | 151-0192-00 | | | TRANSISTOR:NPN,SI,TO-92 | 04713 | SPS8801 |
| Q480 | 151-0190-00 | | | TRANSISTOR:NPN,SI,TO-92 | 80009 | 151-0190-00 |
| Q484 | 151-0302-00 | | | TRANSISTOR:NPN,SI,TO-18 | 04713 | ST899 |
| Q486 | 151-0302-00 | | | TRANSISTOR:NPN,SI,TO-18 | 04713 | ST899 |
| Q488 | 151-0426-00 | | | TRANSISTOR:NPN,SI,TO-220 | 80009 | 151-0426-00 |
| Q525 | 151-0444-00 | | | TRANSISTOR:NPN,SI,TO-92 | 04713 | SPS797 |
| Q527 | 151-1093-00 | | | TRANSISTOR:FE,N CHANNEL,SI,TO-92 | 22229 | F2996 |
| Q528 | 151-0410-00 | | | TRANSISTOR:PNP,SI,TO-92 | 04713 | SPS6765 |
| R101 | 315-0106-00 | | | RES,FXD,FILM:10M OHM,5%,0.25W | 01121 | CB1065 |
| R103 | 325-0136-00 | | | RES,FXD,FILM:9.9M OHM & 101.1M OHM | 03888 | A3DT24 |
| R106 | ----- ----- | | | (PART OF R103) | | |
| R108 | 325-0135-00 | | | RES,FXD,FILM:9&1.111 MEG OHM,0.5%,0.25W | 03888 | A3DT23 |
| R109 | ----- ----- | | | (PART OF R108) | | |
| R111 | 325-0137-00 | | | RES,FXD,FILM:10 M OHM,0.5%,0.25W,150PPM | 03888 | PME62S 10M+-.5% |
| R115 | 307-0400-00 | | | RES,FXD,FILM:10 OHM,0.1% | 80009 | 307-0400-00 |
| R117 | 321-0895-07 | | | RES,FXD,FILM:90 OHM,0.1%,0.125W,TC=T9 | 57668 | RB14 BZE 90E |
| R118 | 321-0754-07 | | | RES,FXD,FILM:900 OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE900R0B |
| R120 | 322-0289-07 | | | RES,FXD,FILM:10K 0.1%,0.25W,TC=T9 | 24546 | NE60E1002B |
| R121 | 321-0993-07 | | | RES,FXD,FILM:90K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE90K00B |
| R122 | 325-0102-00 | | | RES,FXD,FILM:900K OHM,0.1%,0.25W,TC=T9 | 03888 | PME60-900K 1% T9 |
| R123 | 325-0103-00 | | | RES,FXD,FILM:9M OHM,0.1%,0.25W,TC=T9 | 03888 | A3AT32 PME62S 9M |
| R124 | 321-0306-00 | | | RES,FXD,FILM:15.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED15J00F |
| R125 | 321-0335-00 | | | RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0 | 57668 | RB14FXE30K1 |
| R126 | 321-0331-00 | | | RES,FXD,FILM:27.4K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED27K40F |
| R127 | 321-0289-00 | | | RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED10K0F |
| R128 | 321-0206-00 | | | RES,FXD,FILM:1.37K OHM,1%,0.125W,TC=T0 | 07716 | CEAD13700F |
| R129 | 321-0165-00 | | | RES,FXD,FILM:511 OHM,1%,0.125W,TC=T0 | 07716 | CEAD511R0F |
| R130 | 311-1535-00 | | | RES,VAR,NONWW:PNL,2K OHM,0.5W,W/SW | 01121 | GH-8151 |
| R132 | 311-1566-00 | | | RES,VAR,NONWW:TRMR,200 OHM,0.5W | 32997 | 3352T-1-201 |
| R133 | 321-0155-00 | | | RES,FXD,FILM:402 OHM,1%,0.125W,TC=T0 | 07716 | CEAD402R0F |
| R134 | 315-0113-00 | | | RES,FXD,FILM:11K OHM,5%,0.25W | 19701 | 5043CX11K00J |
| R135 | 311-1500-00 | | | RES,VAR,NONWW:PNL,5K OHM,0.5W | 01121 | W-8097 |
| R136 | 315-0470-00 | | | RES,FXD,FILM:47 OHM,5%,0.25W | 57668 | NTR25J-E47E0 |
| R137 | 315-0470-00 | | | RES,FXD,FILM:47 OHM,5%,0.25W | 57668 | NTR25J-E47E0 |
| R140 | 315-0123-00 | | | RES,FXD,FILM:12K OHM,5%,0.25W | 57668 | NTR25J-E12K0 |
| R141 | 307-1041-00 | | | RES,FXD,FILM:M;5 RESISTOR NETWORK | 80009 | 307-1041-00 |
| R142 | 315-0474-00 | | | RES,FXD,FILM:470K OHM,5%,0.25W | 19701 | 5043CX470K0J92U |
| R143 | 321-0343-00 | | | RES,FXD,FILM:36.5K OHM,1%,0.125W,TC=T0 | 07716 | CEAD36501F |
| R144 | 315-0752-00 | | | RES,FXD,FILM:7.5K OHM,5%,0.25W | 57668 | NTR25J-E07K5 |
| R145 | 311-0622-01 | | | RES,VAR,NONWW:TRMR,100 OHM,0.5W | 32997 | 3329H-K28-101 |
| R146 | 315-0202-00 | | | RES,FXD,FILM:2K OHM,5%,0.25W | 57668 | NTR25J-E 2K |
| R147 | 315-0202-00 | | | RES,FXD,FILM:2K OHM,5%,0.25W | 57668 | NTR25J-E 2K |
| R150 | 315-0222-00 | | | RES,FXD,FILM:2.2K OHM,5%,0.25W | 57668 | NTR25J-E02K2 |
| R152 | 311-1244-00 | | | RES,VAR,NONWW:TRMR,100 OHM,0.5W | 32997 | 3386X-T07-101 |
| R153 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R154 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R156 | 315-0151-00 | | | RES,FXD,FILM:150 OHM,5%,0.25W | 57668 | NTR25J-E150E |
| R157 | 315-0104-00 | | | RES,FXD,FILM:100K OHM,5%,0.25W | 57668 | NTR25J-E100K |
| R158 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R159 | 315-0271-00 | | | RES,FXD,FILM:270 OHM,5%,0.25W | 57668 | NTR25J-E270E |
| R161 | 315-0473-00 | | | RES,FXD,FILM:47K OHM,5%,0.25W | 57668 | NTR25J-E47K0 |
| R162 | 315-0272-00 | | | RES,FXD,FILM:2.7K OHM,5%,0.25W | 57668 | NTR25J-E02K7 |
| R163 | 315-0472-00 | | | RES,FXD,FILM:4.7K OHM,5%,0.25W | 57668 | NTR25J-E04K7 |
| R164 | 315-0472-00 | | | RES,FXD,FILM:4.7K OHM,5%,0.25W | 57668 | NTR25J-E04K7 |
| R165 | 321-0222-00 | | | RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED2K00F |
| R166 | 315-0153-00 | | | RES,FXD,FILM:15K OHM,5%,0.25W | 19701 | 5043CX15K00J |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| R167 | 315-0332-00 | | | RES,FXD,FILM:3.3K OHM,5%,0.25W | 57668 | NTR25J-E03K3 |
| R170 | 315-0472-00 | | | RES,FXD,FILM:4.7K OHM,5%,0.25W | 57668 | NTR25J-E04K7 |
| R172 | 315-0473-00 | | | RES,FXD,FILM:47K OHM,5%,0.25W | 57668 | NTR25J-E47K0 |
| R173 | 315-0472-00 | | | RES,FXD,FILM:4.7K OHM,5%,0.25W | 57668 | NTR25J-E04K7 |
| R174 | 321-0268-00 | | | RES,FXD,FILM:6.04K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED6K040F |
| R175 | 315-0470-00 | | | RES,FXD,FILM:47 OHM,5%,0.25W | 57668 | NTR25J-E47E0 |
| R176 | 315-0472-00 | | | RES,FXD,FILM:4.7K OHM,5%,0.25W | 57668 | NTR25J-E04K7 |
| R177 | 315-0204-00 | | | RES,FXD,FILM:200K OHM,5%,0.25W | 19701 | 5043CX200K0J |
| R178 | 321-0223-00 | | | RES,FXD,FILM:2.05K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED2K05F |
| R179 | 315-0104-00 | | | RES,FXD,FILM:100K OHM,5%,0.25W | 57668 | NTR25J-E100K |
| R180 | 315-0243-00 | | | RES,FXD,FILM:24K OHM,5%,0.25W | 57668 | NTR25J-E24K0 |
| R182 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R183 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R184 | 321-0289-07 | B010100 | B039999 | RES,FXD,FILM:10.0K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE10K00B |
| R184 | 321-0816-07 | B040000 | | RES,FXD,FILM:5K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE5K000B |
| R185 | 311-1241-00 | | | RES,VAR,NONWW:TRMR,100K OHM,0.5W | 32997 | 3386X-T07-104 |
| R186 | 315-0824-00 | | | RES,FXD,FILM:820K OHM,5%,0.25W | 19701 | 5043CX820K0J |
| R187 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R188 | 311-1245-00 | | | RES,VAR,NONWW:TRMR,10K OHM,0.5W | 32997 | 3386X-DY6-103 |
| R189 | 315-0182-00 | | | RES,FXD,FILM:1.8K OHM,5%,0.25W | 57668 | NTR25J-E1K8 |
| R190 | 321-0986-07 | | | RES,FXD,FILM:25K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE25K00B |
| R191 | 321-0193-07 | | | RES,FXD,FILM:1K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE1K000B |
| R192 | 321-0193-07 | | | RES,FXD,FILM:1K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE1K000B |
| R193 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R194 | 315-0105-00 | | | RES,FXD,FILM:1M OHM,5%,0.25W | 19701 | 5043CX1M000J |
| R195 | 311-1247-00 | | | RES,VAR,NONWW:TRMR,1MEG OHM,0.5W | 73138 | 72XR1MEG-35B |
| R196 | 315-0102-00 | | | RES,FXD,FILM:1K OHM,5%,0.25W | 57668 | NTR25JE01K0 |
| R197 | 315-0105-00 | | | RES,FXD,FILM:1M OHM,5%,0.25W | 19701 | 5043CX1M000J |
| R198 | 321-0193-07 | | | RES,FXD,FILM:1K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE1K000B |
| R199 | 321-0929-07 | | | RES,FXD,FILM:2.5K OHM,0.1%,0.125W,TC=T9 | 19701 | 5033RE2K500B |
| R203 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R204 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R205 | 315-0153-00 | | | RES,FXD,FILM:15K OHM,5%,0.25W | 19701 | 5043CX15K00J |
| R206 | 315-0223-00 | B010100 | B039999 | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R206 | 315-0223-00 | B040000 | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R213 | 321-0295-09 | | | RES,FXD,FILM:11.5K OHM,1%,0.125W,TC=T9 | 01121 | ORDER BY DESCR |
| R215 | 311-1754-00 | | | RES,VAR,NONWW:TRMR,2K OHM,0.75W | 02111 | 43P202T672 |
| R216 | 315-0752-00 | | | RES,FXD,FILM:7.5K OHM,5%,0.25W | 57668 | NTR25J-E07K5 |
| R217 | 321-0205-00 | | | RES,FXD,FILM:1.33K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED1K330F |
| R220 | 315-0102-00 | | | RES,FXD,FILM:1K OHM,5%,0.25W | 57668 | NTR25JE01K0 |
| R222 | 315-0473-00 | | | RES,FXD,FILM:47K OHM,5%,0.25W | 57668 | NTR25J-E47K0 |
| R224 | 321-0281-00 | B010100 | B039999 | RES,FXD,FILM:8.25K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED8K250F |
| R224 | 321-0252-00 | B040000 | | RES,FXD,FILM:4.12K OHM,1%,0.125W,TC=T0 | 07716 | CEAD41200F |
| R231 | 315-0123-00 | | | RES,FXD,FILM:12K OHM,5%,0.25W | 57668 | NTR25J-E12K0 |
| R232 | 315-0362-00 | | | RES,FXD,FILM:3.6K OHM,5%,0.25W | 19701 | 5043CX3K600J |
| R234 | 315-0563-00 | B010100 | B039999 | RES,FXD,FILM:56K OHM,5%,0.25W | 19701 | 5043CX56K00J |
| R234 | 315-0303-00 | B040000 | | RES,FXD,FILM:30K OHM,5%,0.25W | 19701 | 5043CX30K00J |
| R235 | 311-1340-00 | B010100 | B039999 | RES,VAR,NONWW:TRMR,1K OHM,0.75W | 02111 | 43P102T672 |
| R235 | 311-1489-00 | B040000 | | RES,VAR,NONWW:500 OHM,10%,0.75W | 02111 | 43P501T672 |
| R236 | 308-0439-00 | B010100 | B039999 | RES,FXD,WW:5.83K OHM,5%,3W,TC=10PPM | 00213 | 1240S 583K-0.5 |
| R236 | 308-0498-00 | B040000 | | RES,FXD,WW:2.94K OHM,1%,2.5W,TC=10PPM AXIAL LEADS | 00213 | 1240S-2.94K-1 |
| R240 | 315-0153-00 | | | RES,FXD,FILM:15K OHM,5%,0.25W | 19701 | 5043CX15K00J |
| R243 | 315-0163-00 | | | RES,FXD,FILM:16K OHM,5%,0.25W | 57668 | NTR25J-E 16K |
| R245 | 315-0153-00 | | | RES,FXD,FILM:15K OHM,5%,0.25W | 19701 | 5043CX15K00J |
| R246 | 315-0333-00 | | | RES,FXD,FILM:33K OHM,5%,0.25W | 57668 | NTR25J-E33K0 |
| R247 | 315-0512-00 | | | RES,FXD,FILM:5.1K OHM,5%,0.25W | 57668 | NTR25J-E05K1 |
| R249 | 315-0512-00 | | | RES,FXD,FILM:5.1K OHM,5%,0.25W | 57668 | NTR25J-E05K1 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| R252 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R253 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R254 | 315-0102-00 | B010100 | B039999 | RES,FXD,FILM:1K OHM,5%,0.25W | 57668 | NTR25JE01K0 |
| R254 | 315-0511-00 | B040000 | | RES,FXD,FILM:510 OHM,5%,0.25W | 19701 | 5043CX510R0J |
| R255 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R256 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R258 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R260 | 321-0313-00 | | | RES,FXD,FILM:17.8K OHM,1%,0.125W,TC=T0 | 07716 | CEAD17801F |
| R261 | 315-0753-00 | | | RES,FXD,FILM:75K OHM,5%,0.25W | 57668 | NTR25J-E75K0 |
| R262 | 321-0289-00 | | | RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED10K0F |
| R263 | 315-0753-00 | | | RES,FXD,FILM:75K OHM,5%,0.25W | 57668 | NTR25J-E75K0 |
| R264 | 321-0274-00 | | | RES,FXD,FILM:6.98K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED6K980F |
| R265 | 315-0753-00 | | | RES,FXD,FILM:75K OHM,5%,0.25W | 57668 | NTR25J-E75K0 |
| R266 | 321-0263-00 | | | RES,FXD,FILM:5.36K OHM,1%,0.125W,TC=T0 | 07716 | CEAD53600F |
| R267 | 315-0101-00 | | | RES,FXD,FILM:100 OHM,5%,0.25W | 57668 | NTR25J-E 100E |
| R268 | 315-0512-00 | | | RES,FXD,FILM:5.1K OHM,5%,0.25W | 57668 | NTR25J-E05K1 |
| R269 | 315-0753-00 | | | RES,FXD,FILM:75K OHM,5%,0.25W | 57668 | NTR25J-E75K0 |
| R270 | 315-0124-00 | | | RES,FXD,FILM:120K OHM,5%,0.25W | 19701 | 5043CX120K0J |
| R272 | 321-0443-00 | | | RES,FXD,FILM:402K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED402K0F |
| R274 | 315-0823-00 | | | RES,FXD,FILM:82K OHM,5%,0.25W | 57668 | NTR25J-E82K |
| R275 | 315-0104-00 | | | RES,FXD,FILM:100K OHM,5%,0.25W | 57668 | NTR25J-E100K |
| R280 | 311-1239-00 | | | RES,VAR,NONWW:TRMR,2.5K OHM,0.5W | 32997 | 3386X-T07-252 |
| R282 | 315-0911-00 | | | RES,FXD,FILM:910 OHM,5%,0.25W | 57668 | NTR25J-E910E |
| R284 | 315-0163-00 | | | RES,FXD,FILM:16K OHM,5%,0.25W | 57668 | NTR25J-E 16K |
| R301 | 321-0289-00 | | | RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED10K0F |
| R305 | 307-0308-00 | | | RES,FXD,FILM:2X50K,100K,300K,500K,1MEG OHM, 1.5% | 80009 | 307-0308-00 |
| R306 | 325-0118-00 | | | RES,FXD,FILM:3M OHM,1%,0.125W,TC=TE | 19701 | 5053YL3M0F |
| R310 | 315-0513-00 | | | RES,FXD,FILM:51K OHM,5%,0.25W | 57668 | NTR25J-E51K0 |
| R312 | 311-1556-00 | | | RES,VAR,NONWW:TRMR,50K OHM,0.5W | 32997 | 3352T-DY7-503 |
| R313 | 315-0513-00 | | | RES,FXD,FILM:51K OHM,5%,0.25W | 57668 | NTR25J-E51K0 |
| R314 | 315-0914-00 | | | RES,FXD,FILM:910K OHM,5%,0.25W | 19701 | 5043CX910K00J |
| R315 | 315-0114-00 | | | RES,FXD,FILM:110K OHM,5%,0.25W | 19701 | 5043CX110K0J |
| R316 | 311-1496-00 | | | RES,VAR,NONWW:PNL,10K OHM,0.5W | 01121 | W-8094 |
| R328 | 315-0472-00 | | | RES,FXD,FILM:4.7K OHM,5%,0.25W | 57668 | NTR25J-E04K7 |
| R329 | 315-0473-00 | B010100 | B010359 | RES,FXD,FILM:47K OHM,5%,0.25W | 57668 | NTR25J-E47K0 |
| R330 | 315-0163-00 | | | RES,FXD,FILM:16K OHM,5%,0.25W | 57668 | NTR25J-E 16K |
| R331 | 315-0104-00 | B010100 | B010359 | RES,FXD,FILM:100K OHM,5%,0.25W | 57668 | NTR25J-E100K |
| R332 | 315-0203-00 | | | RES,FXD,FILM:20K OHM,5%,0.25W | 57668 | NTR25J-E 20K |
| R333 | 315-0105-00 | | | RES,FXD,FILM:1M OHM,5%,0.25W | 19701 | 5043CX1M000J |
| R334 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R340 | 315-0393-00 | | | RES,FXD,FILM:39K OHM,5%,0.25W | 57668 | NTR25J-E39K0 |
| R342 | 323-0306-00 | | | RES,FXD,FILM:15.0K OHM,1%,0.5W,TC=T0 | 75042 | CECT0-1502F |
| R344 | 315-0393-00 | | | RES,FXD,FILM:39K OHM,5%,0.25W | 57668 | NTR25J-E39K0 |
| R345 | 323-0306-00 | | | RES,FXD,FILM:15.0K OHM,1%,0.5W,TC=T0 | 75042 | CECT0-1502F |
| R346 | 321-0139-00 | | | RES,FXD,FILM:274 OHM,1%,0.125W,TC=T0 | 07716 | CEAD274R0F |
| R347 | 321-0161-00 | | | RES,FXD,FILM:464 OHM,1%,0.125W,TC=T0 | 07716 | CEAD464R0F |
| R348 | 321-0139-00 | | | RES,FXD,FILM:274 OHM,1%,0.125W,TC=T0 | 07716 | CEAD274R0F |
| R350 | 315-0183-00 | | | RES,FXD,FILM:18K OHM,5%,0.25W | 19701 | 5043CX18K00J |
| R352 | 315-0511-00 | | | RES,FXD,FILM:510 OHM,5%,0.25W | 19701 | 5043CX510R0J |
| R353 | 315-0562-00 | | | RES,FXD,FILM:5.6K OHM,5%,0.25W | 57668 | NTR25J-E05K6 |
| R354 | 315-0151-00 | | | RES,FXD,FILM:150 OHM,5%,0.25W | 57668 | NTR25J-E150E |
| R355 | 315-0183-00 | | | RES,FXD,FILM:18K OHM,5%,0.25W | 19701 | 5043CX18K00J |
| R356 | 315-0302-00 | | | RES,FXD,FILM:3K OHM,5%,0.25W | 57668 | NTR25J-E03K0 |
| R357 | 315-0681-00 | | | RES,FXD,FILM:680 OHM,5%,0.25W | 57668 | NTR25J-E680E |
| R358 | 315-0222-00 | | | RES,FXD,FILM:2.2K OHM,5%,0.25W | 57668 | NTR25J-E02K2 |
| R360 | 321-0351-00 | | | RES,FXD,FILM:44.2K OHM,1%,0.125W,TC=T0 | 07716 | CEAD44201F |
| R362 | 315-0302-00 | | | RES,FXD,FILM:3K OHM,5%,0.25W | 57668 | NTR25J-E03K0 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| R363 | 315-0272-00 | | | RES,FXD,FILM:2.7K OHM,5%,0.25W | 57668 | NTR25J-E02K7 |
| R364 | 321-0351-00 | | | RES,FXD,FILM:44.2K OHM,1%,0.125W,TC=T0 | 07716 | CEAD44201F |
| R365 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R366 | 321-0190-00 | | | RES,FXD,FILM:931 OHM,1%,0.125W,TC=T0 | 19701 | 5043ED931R0F |
| R368 | 321-0190-00 | | | RES,FXD,FILM:931 OHM,1%,0.125W,TC=T0 | 19701 | 5043ED931R0F |
| R369 | 315-0223-00 | | | RES,FXD,FILM:22K OHM,5%,0.25W | 19701 | 5043CX22K00J92U |
| R370 | 311-1536-00 | | | RES,VAR,NONWW:PNL,5K OHM,0.5W,W/SW | 80009 | 311-1536-00 |
| R371 | 315-0562-00 | | | RES,FXD,FILM:5.6K OHM,5%,0.25W | 57668 | NTR25J-E05K6 |
| R372 | 321-0242-00 | | | RES,FXD,FILM:3.24K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED3K240F |
| R373 | 321-0191-00 | | | RES,FXD,FILM:953 OHM,1%,0.125W,TC=T0 | 07716 | CEAD953R0F |
| R374 | 321-0380-00 | | | RES,FXD,FILM:88.7K OHM,1%,0.125W,TC=T0 | 07716 | CEAD88701F |
| R375 | 321-0289-00 | | | RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED10K0F |
| R376 | 315-0562-00 | | | RES,FXD,FILM:5.6K OHM,5%,0.25W | 57668 | NTR25J-E05K6 |
| R377 | 315-0183-00 | | | RES,FXD,FILM:18K OHM,5%,0.25W | 19701 | 5043CX18K00J |
| R378 | 311-1498-00 | | | RES,VAR,NONWW:PNL,20K OHM,0.5W | 01121 | W-8095 |
| R379 | 315-0562-00 | | | RES,FXD,FILM:5.6K OHM,5%,0.25W | 57668 | NTR25J-E05K6 |
| R382 | 315-0561-00 | | | RES,FXD,FILM:560 OHM,5%,0.25W | 19701 | 5043CX560R0J |
| R383 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R384 | 315-0750-00 | | | RES,FXD,FILM:75 OHM,5%,0.25W | 57668 | NTR25J-E75E0 |
| R386 | 315-0751-00 | | | RES,FXD,FILM:750 OHM,5%,0.25W | 57668 | NTR25J-E750E |
| R390 | 315-0563-00 | | | RES,FXD,FILM:56K OHM,5%,0.25W | 19701 | 5043CX56K00J |
| R392 | 315-0104-00 | | | RES,FXD,FILM:100K OHM,5%,0.25W | 57668 | NTR25J-E100K |
| R393 | 315-0184-00 | | | RES,FXD,FILM:180K OHM,5%,0.25W | 19701 | 5043CX180K0J |
| R394 | 315-0103-00 | B031383 | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R395 | 315-0474-00 | | | RES,FXD,FILM:470K OHM,5%,0.25W | 19701 | 5043CX470K0J92U |
| R412 | 315-0106-00 | | | RES,FXD,FILM:10M OHM,5%,0.25W | 01121 | CB1065 |
| R413 | 315-0106-00 | | | RES,FXD,FILM:10M OHM,5%,0.25W | 01121 | CB1065 |
| R422 | 315-0105-00 | | | RES,FXD,FILM:1M OHM,5%,0.25W | 19701 | 5043CX1M000J |
| R423 | 315-0153-00 | | | RES,FXD,FILM:15K OHM,5%,0.25W | 19701 | 5043CX15K00J |
| R426 | 315-0335-00 | B010100 | B047085 | RES,FXD,FILM:3.3M OHM,5%,0.25W | 01121 | CB3355 |
| R426 | 315-0105-00 | B047086 | B047390 | RES,FXD,FILM:1M OHM,5%,0.25W | 19701 | 5043CX1M000J |
| R426 | 315-0754-00 | B047391 | | RES,FXD,FILM:750K OHM,5%,0.25W,MI | 19701 | 5043CX750K0J |
| R427 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R442 | 321-0289-00 | | | RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED10K0F |
| R443 | 321-0190-00 | | | RES,FXD,FILM:931 OHM,1%,0.125W,TC=T0 | 19701 | 5043ED931R0F |
| R444 | 321-0091-00 | | | RES,FXD,FILM:86.6 OHM,1%,0.125W,TC=T0 | 91637 | CMF55116G86R60F |
| R445 | 321-0154-00 | B010100 | B029999 | RES,FXD,FILM:392 OHM,1%,0.125W,TC=T0 | 07716 | CEAD392R0F |
| R445 | 321-0106-00 | B030000 | | RES,FXD,FILM:124 OHM 1%,0.125W,TC=T0 | 80009 | 321-0106-00 |
| R446 | 315-0391-00 | | | RES,FXD,FILM:390 OHM,5%,0.25W | 57668 | NTR25J-E390E |
| R447 | 308-0771-00 | | | RES,FXD,WW:0.06 OHM,10%,0.3W | 75498 | ORDER BY DESCR |
| R448 | 311-1248-00 | B030000 | | RES,VAR,NONWW:TRMR,500 OHM,0.5W | 32997 | 3386X-T07-501 |
| R449 | 321-0153-00 | B030000 | | RES,FXD,FILM:383 OHM,1%,0.125W,TC=T0 | 07716 | CEAD383R0F |
| R450 | 315-0391-00 | | | RES,FXD,FILM:390 OHM,5%,0.25W | 57668 | NTR25J-E390E |
| R451 | 315-0204-00 | | | RES,FXD,FILM:200K OHM,5%,0.25W | 19701 | 5043CX200K0J |
| R452 | 321-0405-00 | | | RES,FXD,FILM:162K OHM,1%,0.125W,TC=T0 | 07716 | CEAD16202F |
| R453 | 321-0330-00 | | | RES,FXD,FILM:26.7K OHM,1%,0.125W,TC=T0 | 07716 | CEAD26701F |
| R454 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R455 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R456 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R457 | 315-0752-00 | | | RES,FXD,FILM:7.5K OHM,5%,0.25W | 57668 | NTR25J-E07K5 |
| R458 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R459 | 315-0392-00 | | | RES,FXD,FILM:3.9K OHM,5%,0.25W | 57668 | NTR25J-E03K9 |
| R460 | 315-0302-00 | | | RES,FXD,FILM:3K OHM,5%,0.25W | 57668 | NTR25J-E03K0 |
| R462 | 315-0104-00 | | | RES,FXD,FILM:100K OHM,5%,0.25W | 57668 | NTR25J-E100K |
| R464 | 315-0242-00 | | | RES,FXD,FILM:2.4K OHM,5%,0.25W | 57668 | NTR25J-E02K4 |
| R465 | 315-0243-00 | | | RES,FXD,FILM:24K OHM,5%,0.25W | 57668 | NTR25J-E24K0 |
| R466 | 321-0306-00 | | | RES,FXD,FILM:15.0K OHM,1%,0.125W,TC=T0 | 19701 | 5033ED15J00F |
| R467 | 311-1238-00 | | | RES,VAR,NONWW:TRMR,5K OHM,0.5W | 32997 | 3386X-DY6-502 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| R468 | 321-0327-00 | | | RES,FXD,FILM:24.9K OHM,1%,0.125W,TC=T0 | 07716 | CEAD24901F |
| R470 | 315-0302-00 | | | RES,FXD,FILM:3K OHM,5%,0.25W | 57668 | NTR25J-E03K0 |
| R472 | 315-0124-00 | | | RES,FXD,FILM:120K OHM,5%,0.25W | 19701 | 5043CX120K0J |
| R473 | 315-0221-00 | | | RES,FXD,FILM:220 OHM,5%,0.25W | 57668 | NTR25J-E220E |
| R474 | 315-0113-00 | | | RES,FXD,FILM:11K OHM,5%,0.25W | 19701 | 5043CX11K00J |
| R475 | 315-0431-00 | | | RES,FXD,FILM:430 OHM,5%,0.25W | 19701 | 5043CX430R0J |
| R476 | 321-0323-00 | | | RES,FXD,FILM:22.6K OHM,1%,0.125W,TC=T0 | 07716 | CEAD22601F |
| R477 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R480 | 315-0103-00 | | | RES,FXD,FILM:10K OHM,5%,0.25W | 19701 | 5043CX10K00J |
| R482 | 315-0331-00 | | | RES,FXD,FILM:330 OHM,5%,0.25W | 57668 | NTR25J-E330E |
| R484 | 315-0911-00 | | | RES,FXD,FILM:910 OHM,5%,0.25W | 57668 | NTR25J-E910E |
| R522 | 315-0625-00 | | | RES,FXD,FILM:6.2M OHM,5%,0.25W | 01121 | CB6255 |
| R523 | 315-0275-00 | | | RES,FXD,FILM:2.7M OHM,5%,0.25W | 01121 | CB2755 |
| R524 | 315-0203-00 | | | RES,FXD,FILM:20K OHM,5%,0.25W | 57668 | NTR25J-E 20K |
| R525 | 311-1247-00 | | | RES,VAR,NONWW:TRMR,1MEG OHM,0.5W | 73138 | 72XR1MEG-35B |
| R526 | 321-0452-00 | | | RES,FXD,FILM:499K OHM,1%,0.125W,TC=T0 | 19701 | 5043ED499K0F |
| R527 | 315-0102-00 | | | RES,FXD,FILM:1K OHM,5%,0.25W | 57668 | NTR25JE01K0 |
| R528 | 307-0375-00 | | | RES,FXD,FILM:100 MEG OHM | 80009 | 307-0375-00 |
| R530 | 315-0475-00 | | | RES,FXD,FILM:4.7M OHM,5%,0.25W | 01121 | CB4755 |
| R532 | 315-0475-00 | | | RES,FXD,FILM:4.7M OHM,5%,0.25W | 01121 | CB4755 |
| R533 | 315-0473-00 | | | RES,FXD,FILM:47K OHM,5%,0.25W | 57668 | NTR25J-E47K0 |
| R534 | 315-0334-00 | | | RES,FXD,FILM:330K OHM,5%,0.25W | 57668 | NTR25J-E 330K |
| R535 | 311-1243-00 | | | RES,VAR,NONWW:TRMR,500K OHM,0.5W | 32997 | 3386X-T07-504 |
| R536 | 315-0274-00 | | | RES,FXD,FILM:270K OHM,5%,0.25W | 57668 | NTR25J-E270K |
| R537 | 315-0100-00 | | | RES,FXD,FILM:10 OHM,5%,0.25W | 19701 | 5043CX10RR00J |
| R538 | 315-0100-00 | | | RES,FXD,FILM:10 OHM,5%,0.25W | 19701 | 5043CX10RR00J |
| R560 | 311-1495-00 | | | RES,VAR,NONWW:PNL,2M OHM,0.5W | 01121 | W-8093 |
| R565 | 311-1550-00 | | | RES,VAR,NONWW:TRMR,2M OHM,0.5W | 32997 | 3352T-1-205 |
| R570 | 311-1269-00 | | | RES,VAR,NONWW:TRMR,20K OHM,0.5W | 32997 | 3329P-L58-203 |
| R575 | 311-1242-00 | | | RES,VAR,NONWW:TRMR,200K OHM,0.5W | 32997 | 3386X-T07-204 |
| R580 | 311-1241-00 | | | RES,VAR,NONWW:TRMR,100K OHM,0.5W | 32997 | 3386X-T07-104 |
| S100 | 105-0661-00 | | | ACTUATOR,SWITCH:SLIDE,W/O CONTACTS | 80009 | 105-0661-00 |
| S120 | 105-0451-00 | | | ACTUATOR,CAM SW:ATTENUATOR | 80009 | 105-0451-00 |
| S155 | 260-1479-00 | B010100 | B042829 | SWITCH,PUSH:4 POLE,PUSH-PUSH,INTERLOCK | 80009 | 260-1479-00 |
| S155 | 260-1479-01 | B042830 | | SWITCH,PUSH:5 BTN,2/4 POLE,FUNCTION SEL | 59821 | 2KBM0230001143 |
| S160 | 260-1479-00 | B010100 | B042829 | SWITCH,PUSH:4 POLE,PUSH-PUSH,INTERLOCK | 80009 | 260-1479-00 |
| S160 | 260-1479-01 | B042830 | | SWITCH,PUSH:5 BTN,2/4 POLE,FUNCTION SEL | 59821 | 2KBM0230001143 |
| S185 | 260-1479-00 | B010100 | B042829 | SWITCH,PUSH:4 POLE,PUSH-PUSH,INTERLOCK | 80009 | 260-1479-00 |
| S185 | 260-1479-01 | B042830 | | SWITCH,PUSH:5 BTN,2/4 POLE,FUNCTION SEL | 59821 | 2KBM0230001143 |
| S300 | 105-0453-00 | | | ACTUATOR,CAM SW:TIME/DIV | 80009 | 105-0453-00 |
| S315 | 260-0984-01 | | | SWITCH,SLIDE:DPTT W/PLASTIC PLATE | 79727 | G-128-S-0095 |
| S480 | 260-0723-00 | | | SWITCH,SLIDE:DPDT,0.5A,125VAC | 79727 | GF126-0028 |
| T415 | 120-0738-00 | | | TRANSFORMER,CMR: | 75498 | ORDER BY DESCR |
| T423 | 120-0946-00 | | | XFMR,BASE DRIVE: | 75498 | ORDER BY DESCR |
| T430 | 120-0960-00 | | | TRANSFORMER,RF:BATTERY CHARGER | 75498 | ORDER BY DESCR |
| T490 | 120-0959-00 | | | TRANSFORMER,RF:POT CORE | 75498 | ORDER BY DESCR |
| U175 | 156-0495-01 | | | MICROCKT,LINEAR:OPNL AMPL,SELECTED | 01295 | LM224J |
| U180 | 156-0317-00 | | | MICROCKT,LINEAR:BIPOLAR,OP-AMP,WIDEBAND | 80009 | 156-0317-00 |
| U186 | 156-0317-00 | | | MICROCKT,LINEAR:BIPOLAR,OP-AMP,WIDEBAND | 80009 | 156-0317-00 |
| U188 | 156-0067-00 | | | MICROCKT,LINEAR:BIPOLAR,OPNL AMPL | 04713 | MC1741CP1 |
| U220 | 156-0200-00 | | | MICROCKT,LINEAR:OPNL AMPL | 04713 | MC1456P1 |
| U250 | 156-0113-03 | B010100 | B047168 | MICROCKT,DGTL:QUAD 2 INP NAND GATE,SCRN, | 01295 | SN74L00NP3 |
| U250 | 156-0113-00 | B047169 | | MICROCKT,DGTL:QUAD 2-INP NAND GATE,74L00, TTL,14 DIP | 80009 | 156-0113-00 |
| U260 | 156-0409-00 | | | MICROCKT,DGTL:MOS,4-DECADE COUNTER | 60496 | MIC5007P |
| U270 | 155-0114-00 | | | MICROCKT,DGTL:BCD/7 SEG NUM GEN | 80009 | 155-0114-00 |
| U335 | 155-0048-01 | | | MICROCKT,DGTL:SELECTED FOR LEVEL RANGE | 80009 | 155-0048-01 |
| U365 | 156-0259-00 | | | MICROCKT,LINEAR:5-XSTR,ALL INDEPENDENT | 02735 | CA3083 |

| Component No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|
| U450 | 156-0067-00 | | | MICROCKT,LINEAR:BIPOLAR,OPNL AMPL | 04713 | MC1741CP1 |
| V560 | 154-0696-00 | | | ELECTRON TUBE:CRT,P43,INT SCALE (FURNISHED AS A UNIT WITH L500) | 80009 | 154-0696-00 |
| VR165 | 152-0279-00 | | | SEMICOND DVC,DI:ZEN,SI,5.1V,5%,0.4W,DO-7 | 14552 | TD3810989 |
| VR188 | 152-0149-00 | | | SEMICOND DVC,DI:ZEN,SI,10V,5%,0.4W,DO-7 | 04713 | 1N961B |
| VR217 | 152-0317-00 | | | SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-35 | 04713 | 1N825 |
| VR362 | 152-0127-00 | | | SEMICOND DVC,DI:ZEN,SI,7.5V,5%,0.4W,DO-7 | 04713 | IN958B |
| VR395 | 152-0284-00 | | | SEMICOND DVC,DI:ZEN,SI,47V,5%,0.4W,DO-7 | 80009 | 152-0284-00 |
| VR440 | 152-0280-00 | | | SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7 OR DO-35 | 04713 | 1N753A |
| VR458 | 152-0127-00 | | | SEMICOND DVC,DI:ZEN,SI,7.5V,5%,0.4W,DO-7 | 04713 | IN958B |
| VR460 | 152-0359-00 | | | SEMICOND DVC,DI:ZEN,SI,9V,5%,0.25W,DO-7 | 04713 | SZ50850 |
| VR535 | 152-0470-00 | | | SEMICOND DVC,DI:ZEN,SI,200V,5%,0.4W,DO-7 | 80009 | 152-0470-00 |

# DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

## Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).

Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

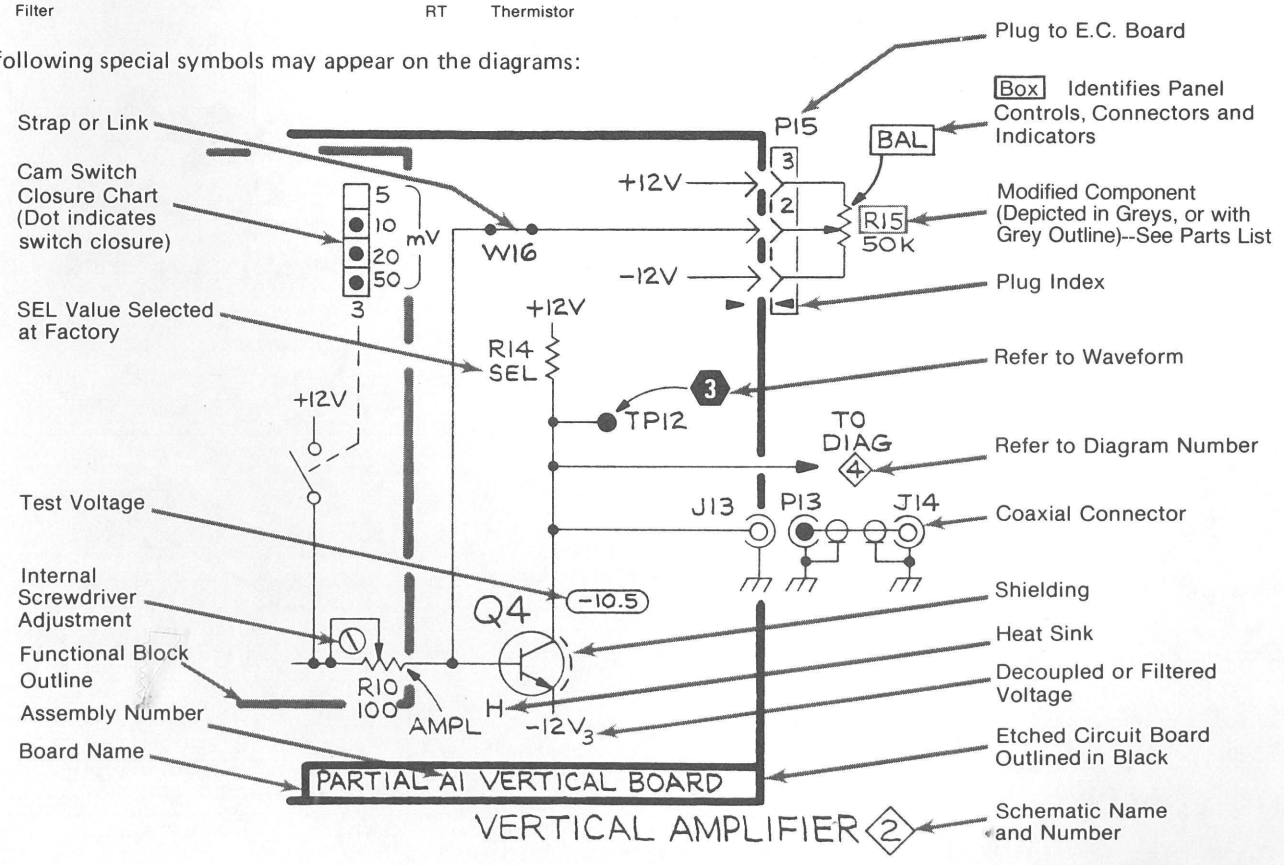
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

| | |
|---|---|
| Y14.15, 1966 | Drafting Practices. |
| Y14.2, 1973 | Line Conventions and Lettering. |
| Y10.5, 1968 | Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering. |

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

| | | | | | |
|---|---|---|---|---|---|
| A | Assembly, separable or repairable (circuit board, etc) | H | Heat dissipating device (heat sink, heat radiator, etc) | S | Switch or contactor |
| AT | Attenuator, fixed or variable | HR | Heater | T | Transformer |
| B | Motor | HY | Hybrid circuit | TC | Thermocouple |
| BT | Battery | J | Connector, stationary portion | TP | Test point |
| C | Capacitor, fixed or variable | K | Relay | U | Assembly, inseparable or non-repairable (integrated circuit, etc.) |
| CB | Circuit breaker | L | Inductor, fixed or variable | V | Electron tube |
| CR | Diode, signal or rectifier | M | Meter | VR | Voltage regulator (zener diode, etc.) |
| DL | Delay line | P | Connector, movable portion | W | Wirestrap or cable |
| DS | Indicating device (lamp) | Q | Transistor or silicon-controlled rectifier | Y | Crystal |
| E | Spark Gap, Ferrite bead | R | Resistor, fixed or variable | Z | Phase shifter |
| F | Fuse | RT | Thermistor | | |
| FL | Filter | | | | |

The following special symbols may appear on the diagrams:



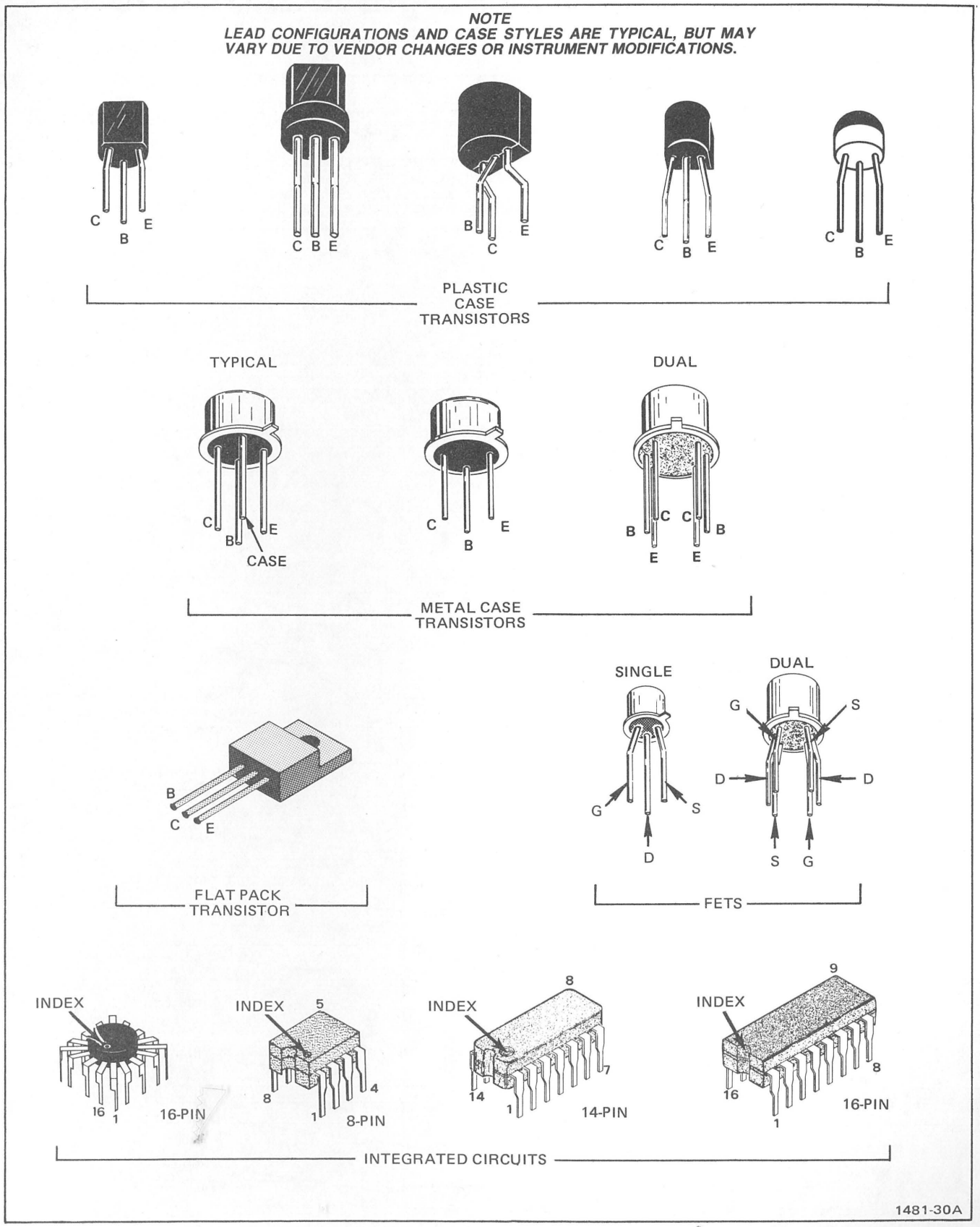



**Fig. 9-1. Semiconductor lead configurations.**

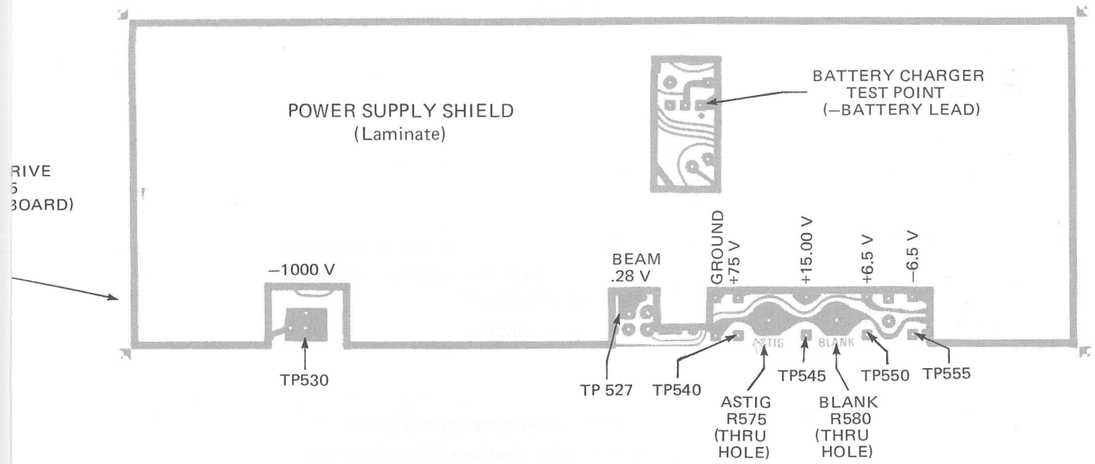



Fig. 9-2. Power Supply test point and adjustment locations.

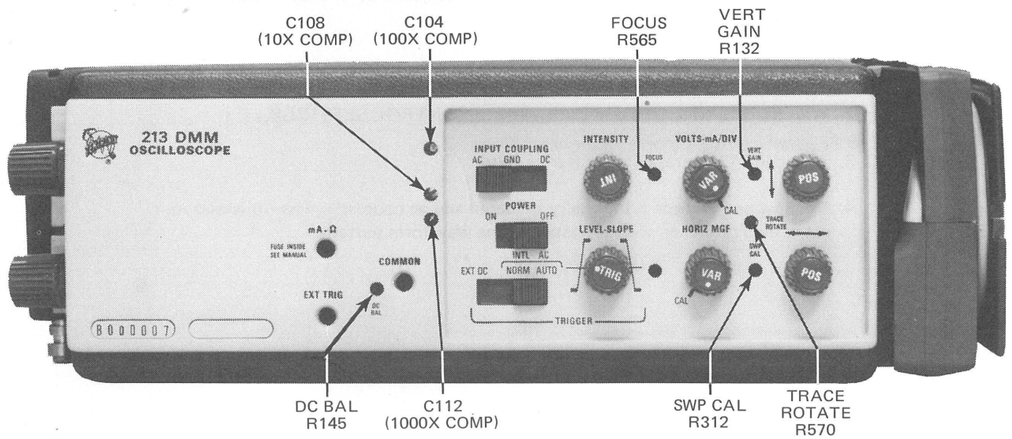
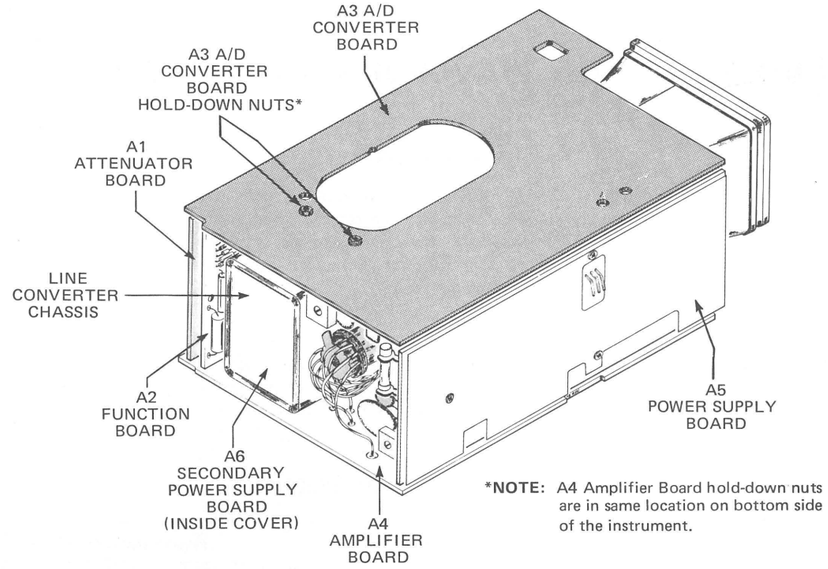



Fig. 9-3. Side panel screwdriver adjustment locations.




***NOTE:** A4 Amplifier Board hold-down nuts are in same location on bottom side of the instrument.

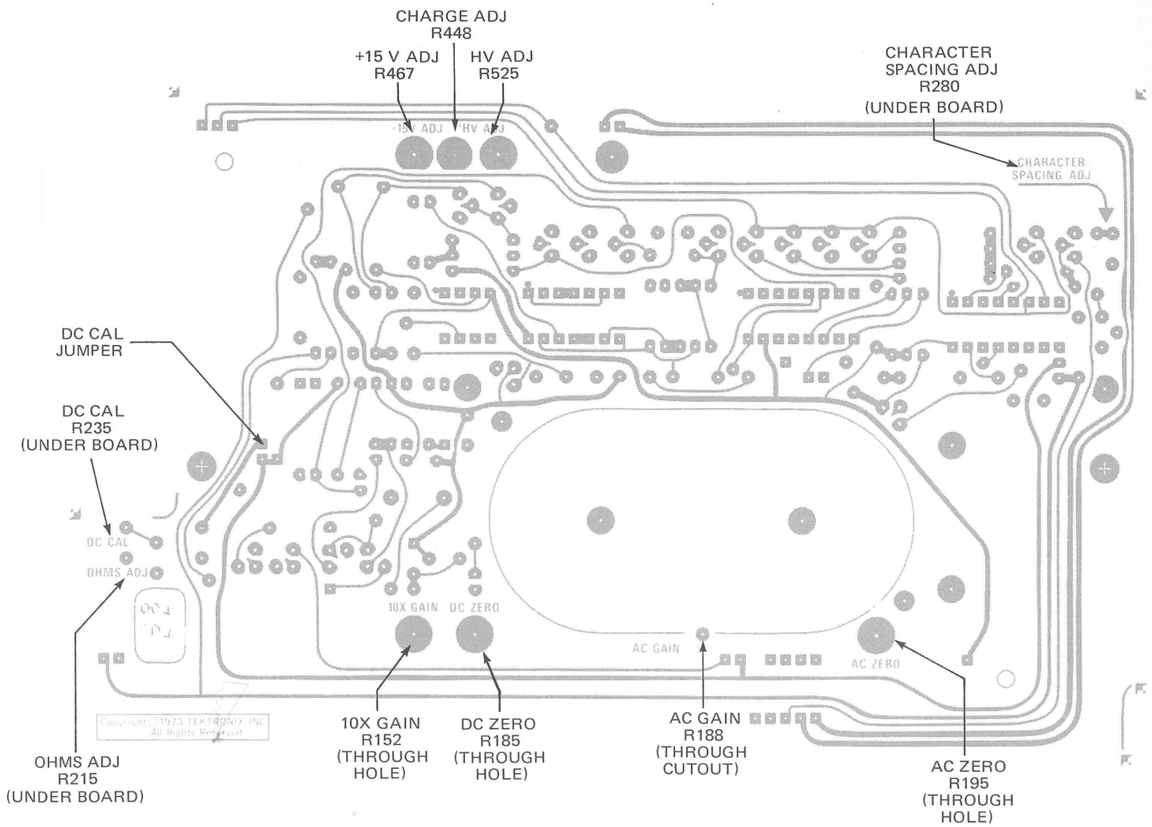



Fig. 9-4. A/D Converter circuit board adjustment locations.

# VOLTAGE AND WAVEFORM CONDITIONS

**WARNING**

*Dangerous potentials exist at several points throughout this instrument. Do not touch connections or components when the instrument is operated with the cabinet halves removed. Some transistors have voltages present on their cases or tabs. Disconnect the power cord plug from the power line, and the batteries before cleaning the instrument or replacing parts.*

The voltages and waveforms shown on the diagrams can be obtained by using the recommended test equipment and test set-ups listed below. Where test set-ups have special conditions, the waveform or voltage is annotated with a number in parenthesis, (e.g. (3) ), and explained in SPECIAL CONDITIONS on the schematic page.

## RECOMMENDED TEST EQUIPMENT

| Item | Specification | | Recommended Type |
|---|---|---|---|
| Oscilloscope | Bandwidth | DC to 1 MHz | a. Tektronix 213 (also provides Digital Multimeter listed below) |
| | Minimum Deflection Factor | 20 mV/div | b. Tektronix 221 |
| | Minimum Time Base | 10 $\mu$s/div | |
| Digital Multimeter (for voltages up to 1 kV) | Input Impedance | 10 MΩ | a. Tektronix DM501 (requires TM500 Power Module) |
| | Range | 0 to 1 kV | b. (DMM portion from 213 above, useable to 800 Vdc) |
| DC Voltmeter (for voltages above 1 kV) | Input Impedance | 20,000 Ω/V | Triplett Model 630NA (also used above 800 Vdc when 213 is used) |
| | Range | 0 to at least 1.5 kV | |
| Pulse Generator | Output Frequency | 1 kHz | Tektronix FG501 (requires TM500 Power Module) |
| | Output Voltage | 4 V p-p | |
| | Duty Factor | 20% | |
| Sinewave Generator | Output Frequency | 1 kHz | Tektronix FG501 (Requires TM500 Power Module) |
| | Output Voltage | 5 V p-p | |

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### 213 Control Settings

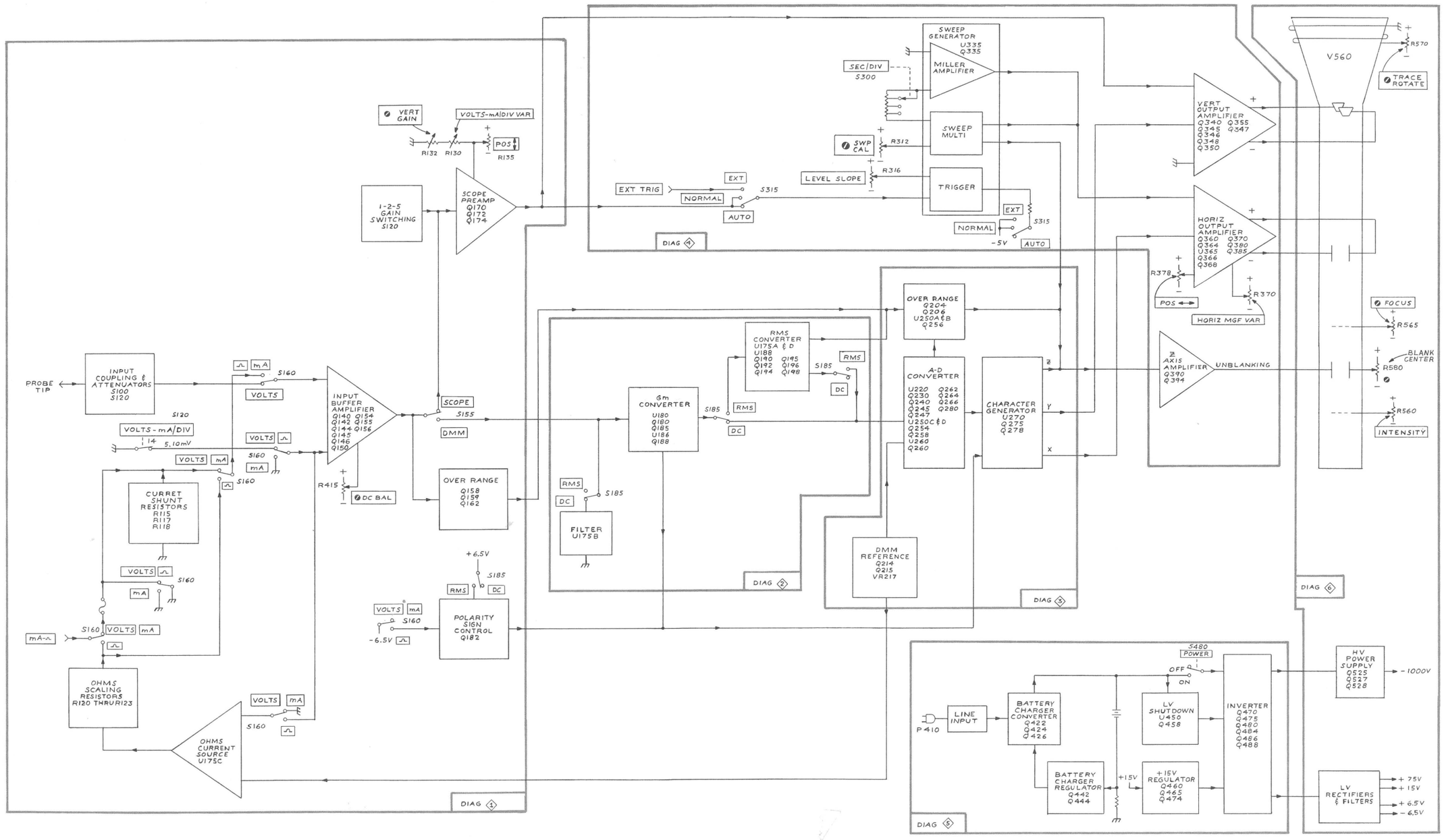
| | |
|---|---|
| VOLTS-mA/DIV | 1 (black scale) |
| SEC/DIV | .2 m |
| RMS | Button out |
| VOLTS | Button in |
| INPUT COUPLING | GND |
| POWER | ON |
| TRIGGER | INTL AC AUTO |
| LEVEL/SLOPE | Midpoint of one of the slopes (adjust for a stable pattern when an input signal is applied) |
| INTENSITY | Minimum for a visible display |
| VOLTS-mA/DIV VAR | CAL detent |
| HORIZ MGF VAR | CAL detent |
| POS (vertical) | Set trace on center horizontal graticule line. |
| POS (horizontal) | Set for trace to end at right vertical graticule line. |
| DMM | Set for mode of operation during which circuit under test is used. Circuits serving both modes of operation are identified with a special condition annotation to show the mode of operation. |

### Measurement Conditions

All measurements are made as follows, unless otherwise noted by SPECIAL CONDITIONS on each diagram pullout page:

1. Between the point under test and instrument common.
2. With the 213 controls set as shown in 213 CONTROL SETTINGS.
3. With the 213 operating on batteries only.
4. The test oscilloscope is internally triggered and ac coupled unless otherwise indicated by a reference voltage shown on the waveform pattern.

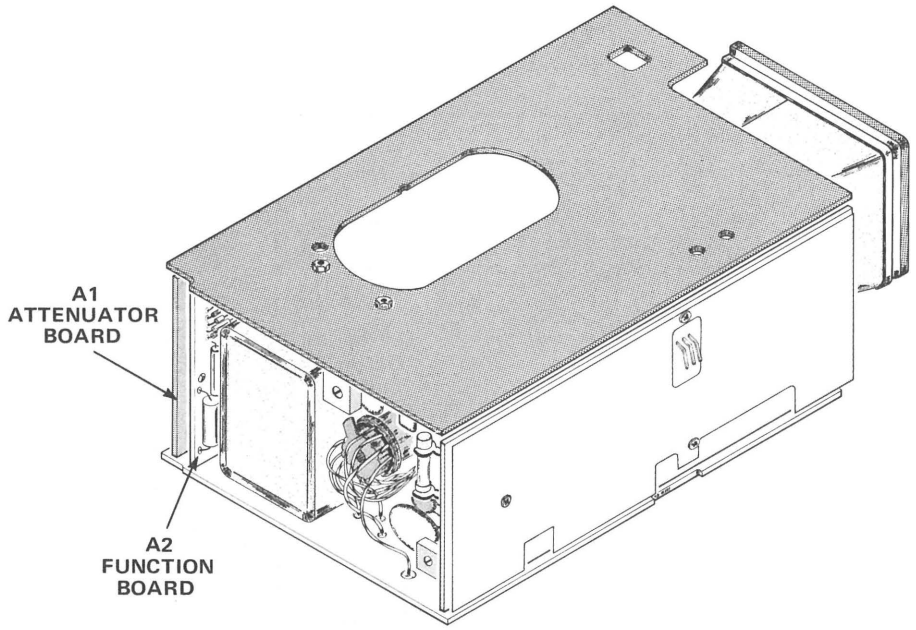
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213 DMM

REV SEP 1984

BLOCK DIAGRAM




MORE

# SPECIAL CONDITIONS

Special conditions are established after all controls are set as specified in 213 CONTROL SETTINGS on the VOLTAGE AND WAVEFORM CONDITIONS pullout page.

(1) DMM mode of operation.

(2) Oscilloscope mode of operation.

(3) Set VOLTS-mA/DIV to 100 kΩ ; Ω button in; connect a 100 kΩ , 0.1% resistor for measurement.

(4) For voltages at test points (17), (18), (19), & (20), see Table 9-1.

**TABLE 9-1**
**Overrange Voltages**

| Test Point | Input Coupling Ground | +5 V INPUT | | –5 V INPUT | |
|---|---|---|---|---|---|
| | | Input Coupling = DC VOLTS-mA/DIV Range | | Input Coupling = DC VOLTS-mA/DIV Range | |
| | | 10 (Blue) (Normal) | 1 (Blue) (Overranged) | 10 (Blue) (Normal) | 1 (Blue) (Overranged) |
| 17 | –0.55 | 0 V | +4.2 | –1 V | –5.3 |
| 18 | +6.4 V | +6.4 V | +6.4 V | +6.4 V | +5.7 V |
| 19 | +0.55 | +1 V | +4.5 V | 0V | –4.2 V |
| 20 | 0 V | 0 V | 0.7 V | 0 | 0.7 V |

(5) Input is a positive 4 V peak pulse at 1 kHz with a duty cycle of 20%; INPUT COUPLING is AC. Pattern is centered vertically on 213.

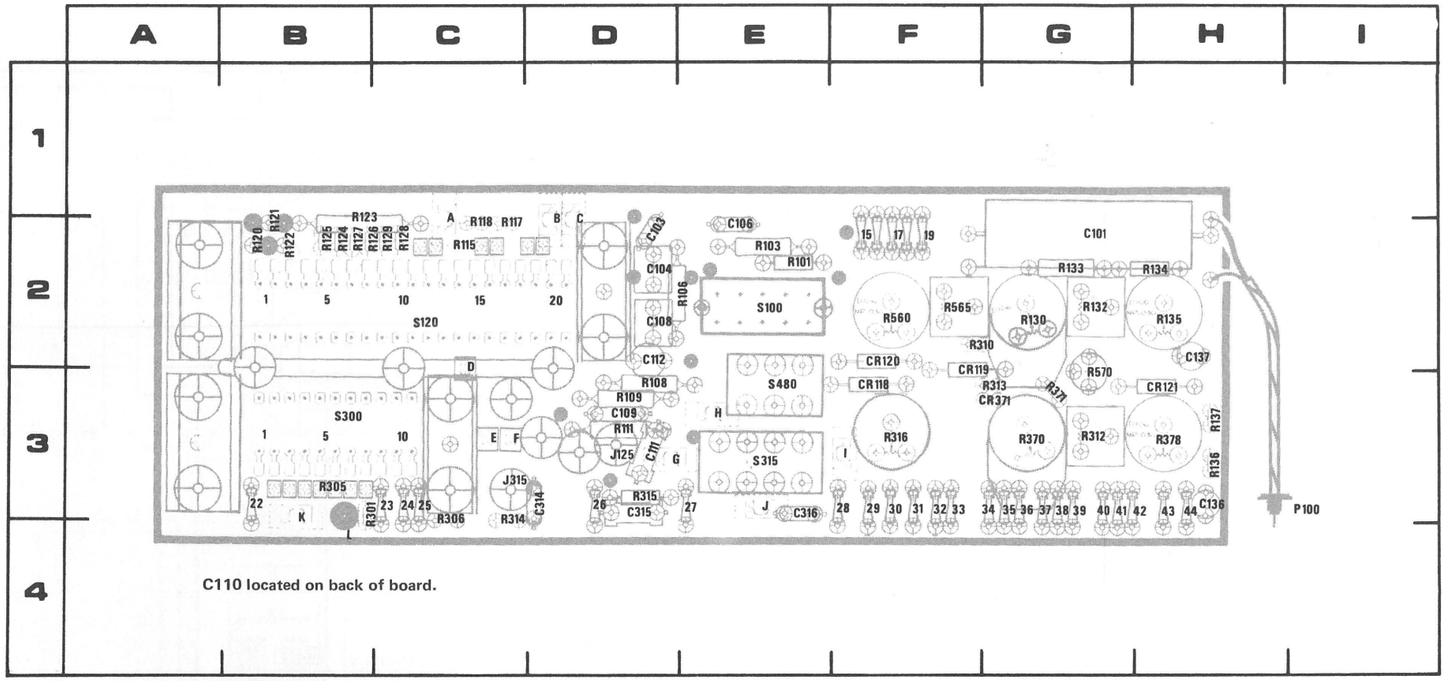



Fig. 9-6. A1 Attenuator circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|
| C101 | 2G | CR120 | 2F | R115 | 2C | R130 | 2G |
| C103 | 2D | CR121 | 3H | R117 | 2C | R132 | 2G |
| C104 | 2D | | | R118 | 2C | R133 | 2G |
| C106 | 2E | J125 | 3D | R120 | 2B | R134 | 2H |
| C108 | 2D | | | R121 | 2B | R135 | 2H |
| C109 | 3D | P100 | 3I | R122 | 2B | R136 | 3H |
| C111 | 3D | | | R123 | 1B | R137 | 3H |
| C112 | 2D | R101 | 2E | R124 | 2B | | |
| C136 | 3H | R103 | 2E | R125 | 2B | S100 | 2E |
| C137 | 2H | R106 | 2E | R126 | 2C | S120 | 2C |
| | | R108 | 3D | R127 | 2B | | |
| CR118 | 3F | R109 | 3D | R128 | 2C | | |
| CR119 | 2F | R111 | 3D | R129 | 2C | | |

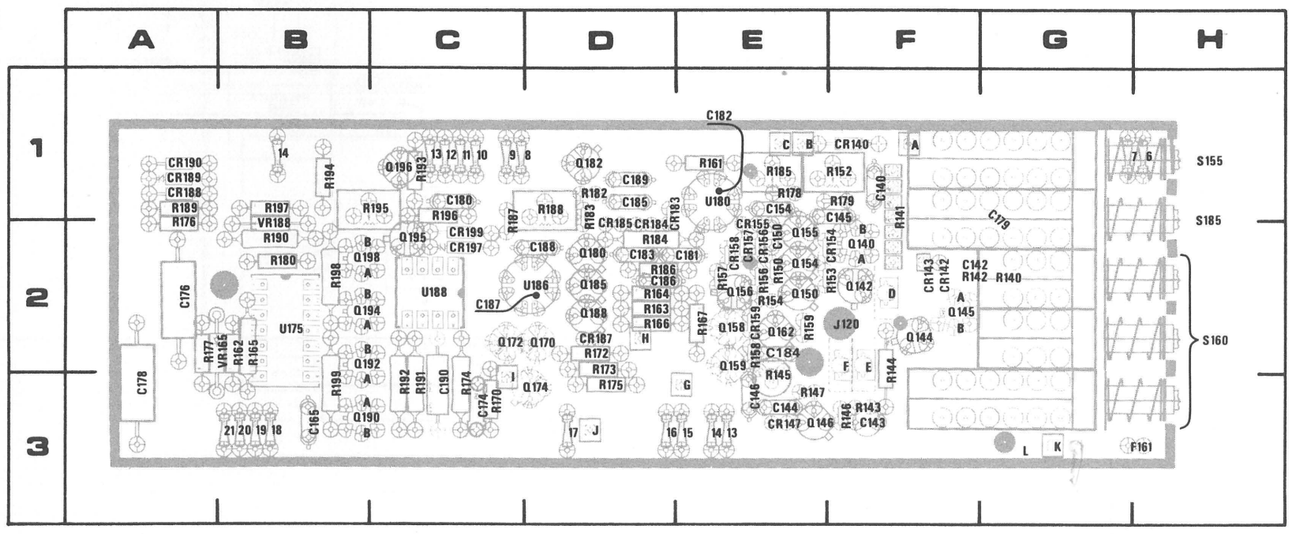



Fig. 9-7. A2 Function circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|
| C140 | 1F | CR155 | 2E | Q155 | 2E | R147 | 3E | R172 | 2D |
| C142 | 2F | CR156 | 2E | Q156 | 2E | R150 | 2E | R173 | 2D |
| C143 | 3F | CR157 | 2E | Q158 | 2E | R152 | 1F | R174 | 3C |
| C144 | 3E | CR158 | 2E | Q159 | 2E | R153 | 2F | R175 | 3D |
| C145 | 1F | CR159 | 2E | Q162 | 2E | R154 | 2E | R178 | 1E |
| C146 | 3E | | | Q170 | 2D | R156 | 2E | R182 | 1D |
| C150 | 2E | F161 | 3H | Q172 | 2C | R157 | 2E | | |
| C154 | 1E | | | Q174 | 3D | R158 | 2E | S155 | 1H |
| C165 | 3B | J120 | 2F | Q182 | 1D | R159 | 2E | S160 | 2H |
| C174 | 3C | | | | | R161 | 1E | S185 | 1H |
| C184 | 2E | Q140 | 2F | R140 | 2G | R162 | 2B | U175 | 2B |
| | | Q142 | 2F | R151 | 1F | R163 | 2D | | |
| CR140 | 1F | Q144 | 2F | R142 | 2F | R164 | 2D | VR165 | 2B |
| CR142 | 2F | Q145 | 2F | R143 | 3F | R165 | 2B | | |
| CR143 | 2F | Q146 | 3E | R144 | 2F | R166 | 2D | | |
| CR147 | 3E | Q150 | 2E | R145 | 3E | R167 | 2E | | |
| CR154 | 2F | Q154 | 2E | R146 | 3F | R170 | 3C | | |

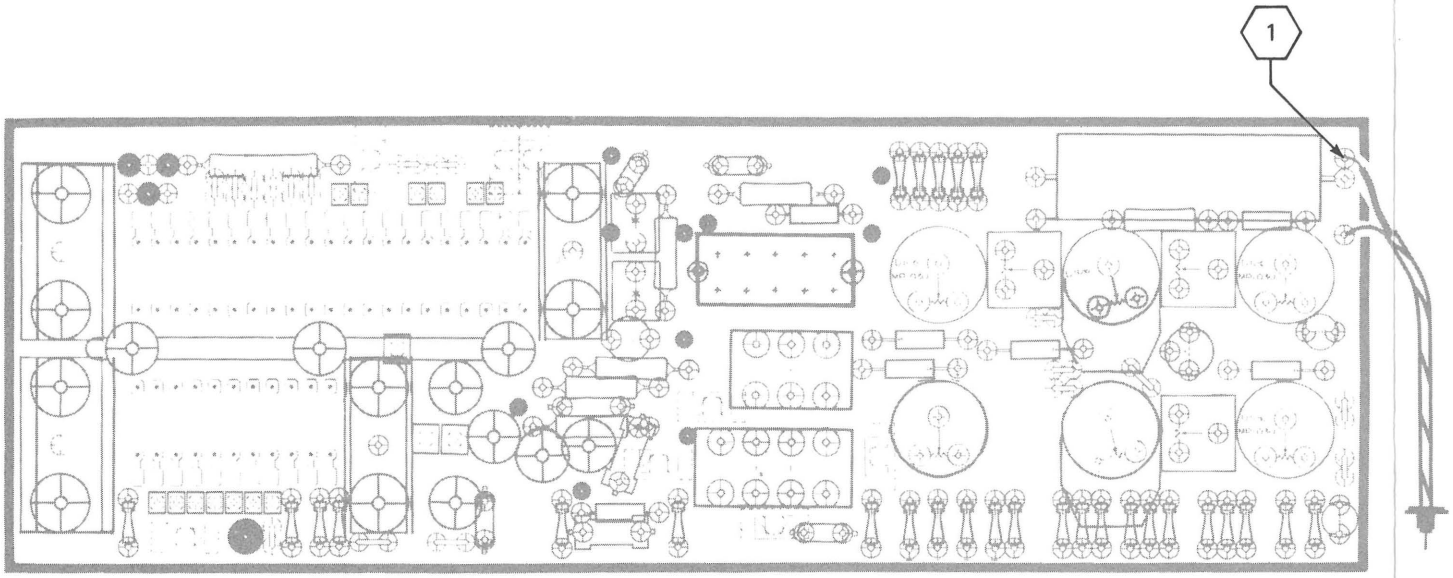



Fig. 9-8. A1 Attenuator circuit board voltage and waveform test points.

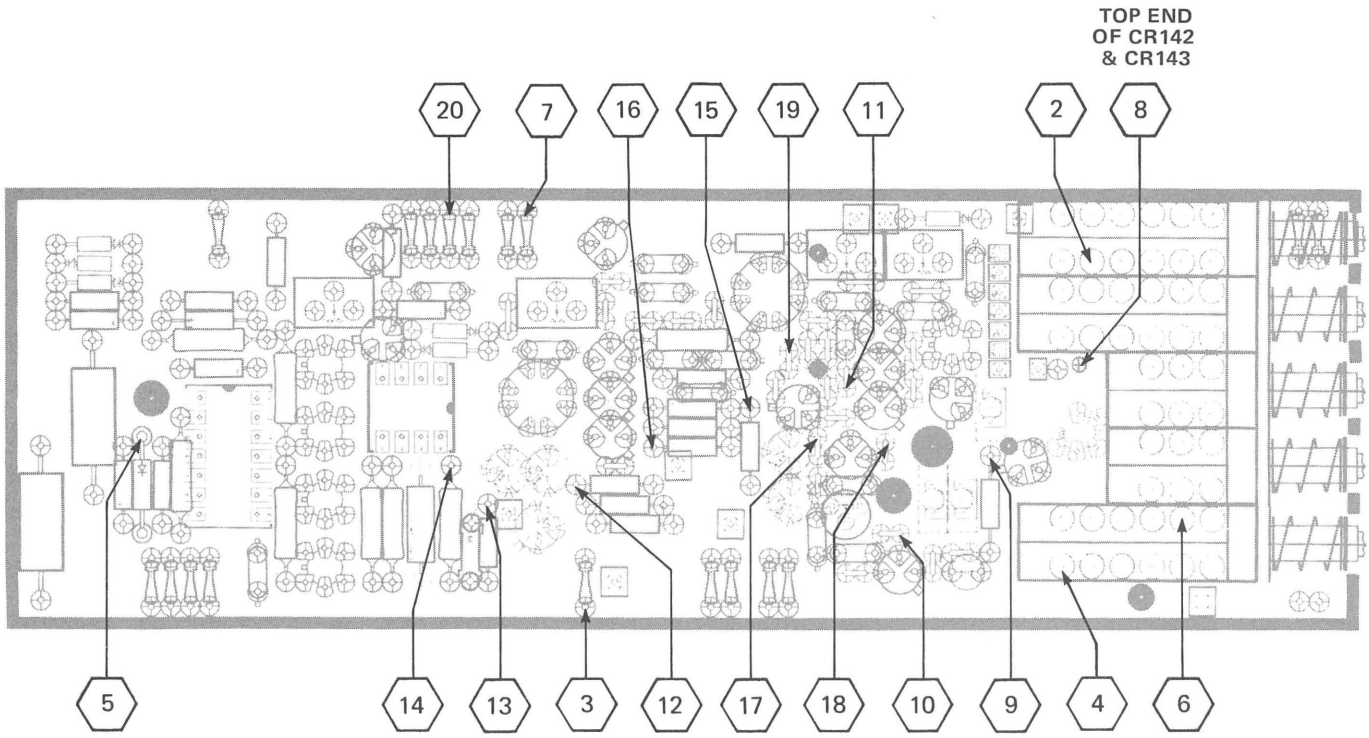



Fig. 9-9. A2 Function circuit board voltage and waveform test points.

S120 VOLTS-mA/DIV (SWITCH SHOWN IN 5mV POSITION)

| DMM |
|---|
| 1000V-mA 10MΩ |
| 100V-mA 1MΩ |
| 10V-mA 100KΩ |
| 1V-mA 10KΩ |
| 0.1V-mA 1KΩ |

PIN LOCATION ON FUNCTION BOARD (A2) PIN D,E,F LOCATED ON ATTENUATOR BOARD (A1)

REFERENCED TO COMPONENT SIDE OF BOARD

S160 (Ω, mA, VOLTS) S185 (RMS) S155 (DMM)

VOLTAGE & WAVEFORM CONDITIONS

DECIMAL POINT SPACING ENABLE TO Q275 ③

-6.5V(D) FROM C237 THRU PIN 16 ③

P100 PROBE TIP

S100 INPUT COUPLING (GND, DC, AC)

100:1 10:1

P/O A1 ATTENUATOR BOARD

J120 mA/Ω

J125 COMMON

213 DMM

OHMS CURRENT SOURCE

U175C 1/4 324

VR165 5.1V

INPUT BUFFER AMPLIFIER

10X GAIN

DC BAL

OUT: SCOPE / DMM S155

P/O A2 FUNCTION BOARD

SCOPE PREAMP

VOLTS-mA/DIV VAR

POS

VERT GAIN

VERT SIGNAL TO C316 ④

VERT SIGNAL TO Q346 ④

DMM ANALOG SIGNAL TO R179 ②

OVER RANGE TO Q204 ③

OVER RANGE

SEE DIAG ② S185 RMS OUT: DC

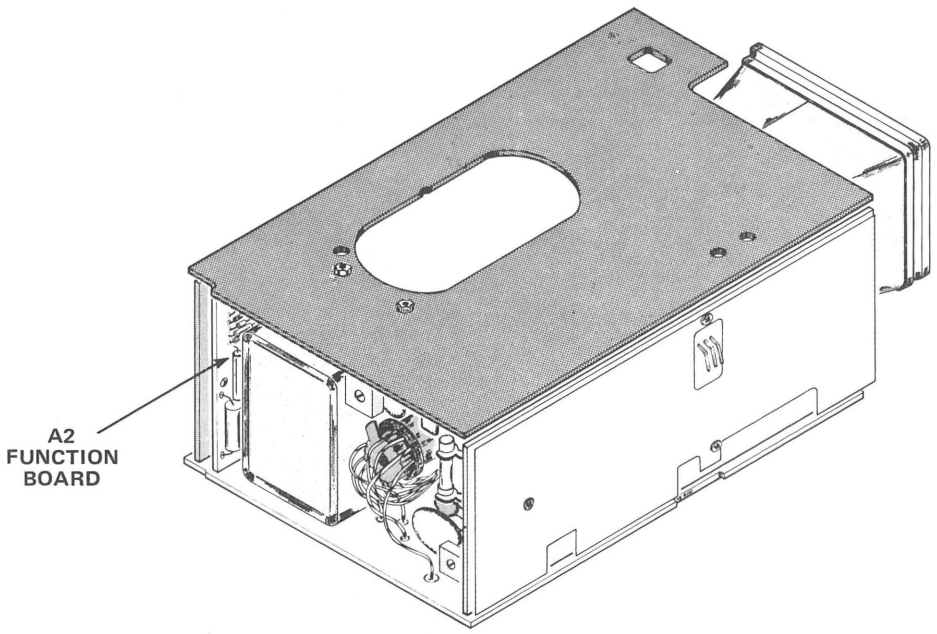
±SIGN OFF TO R267 ③

GND TO PIN 3, U186 ②

DMM REFERENCE FROM Q214 ③

NOTE:
** THICK FILM RESISTOR.
* MATCHED PAIR.

ATTENUATOR & INPUT AMPLIFIER ①




MORE

# SPECIAL CONDITIONS

Special conditions are established after all controls are set as specified in 213 CONTROL SETTINGS on the VOLTAGE AND WAVEFORM CONDITIONS pullout page.

(1) DMM mode of operation.

(6) Input is a 4 V p-p sine wave at 1 kHz; INPUT COUPLING is AC.

(7) RMS button in.

(8) RMS button out.

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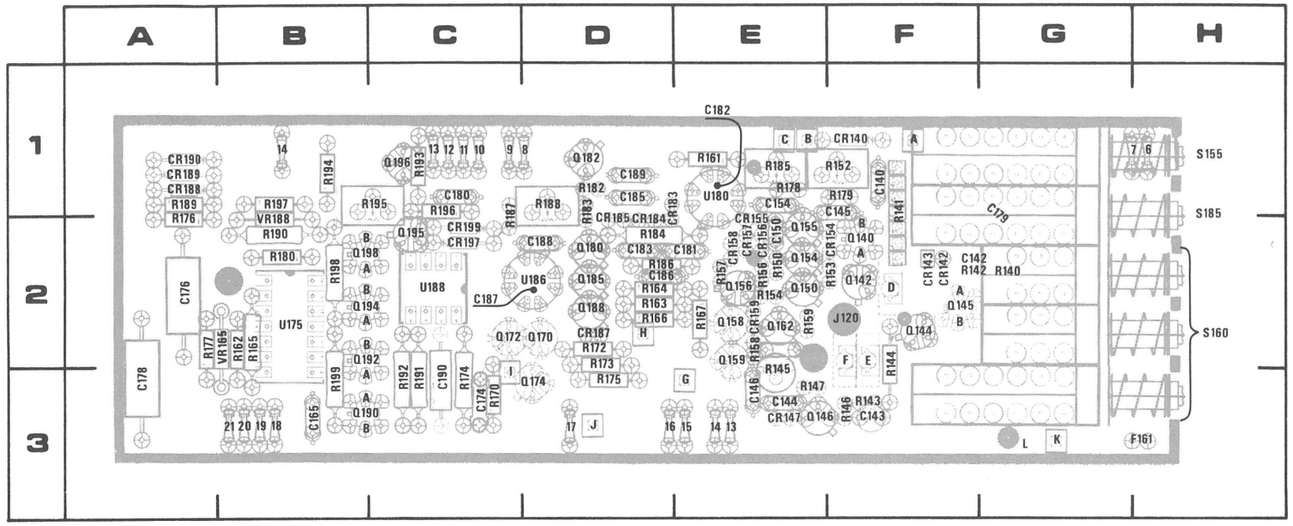



Fig. 9-10. A2 Function circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|
| C176 | 2A | CR185 | 1D | Q198 | 2B | R193 | 1C |
| C178 | 3A | CR187 | 2D | | | R194 | 1B |
| C179 | 1G | CR188 | 1A | R176 | 2A | R195 | 1C |
| C180 | 1C | CR189 | 1A | R177 | 2A | R196 | 1C |
| C181 | 2E | CR190 | 1A | R179 | 1F | R197 | 1B |
| C182 | 1E | CR197 | 2C | R180 | 2B | R198 | 2B |
| C183 | 2D | CR199 | 2C | R183 | 1D | R199 | 3B |
| C185 | 1D | | | R184 | 2D | | |
| C186 | 2D | Q180 | 2D | R185 | 1E | S185 | 1H |
| C187 | 2C | Q185 | 2D | R186 | 2D | | |
| C188 | 2D | Q188 | 2D | R187 | 1C | U175 | 2B |
| C189 | 1D | Q190 | 3B | R188 | 1D | U180 | 1E |
| C190 | 3C | Q192 | 2B | R189 | 1A | U186 | 2D |
| | | Q194 | 2B | R190 | 2B | U188 | 2C |
| CR183 | 1D | Q195 | 2C | R191 | 3C | | |
| CR184 | 1D | Q196 | 1C | R192 | 3C | VR188 | 2B |

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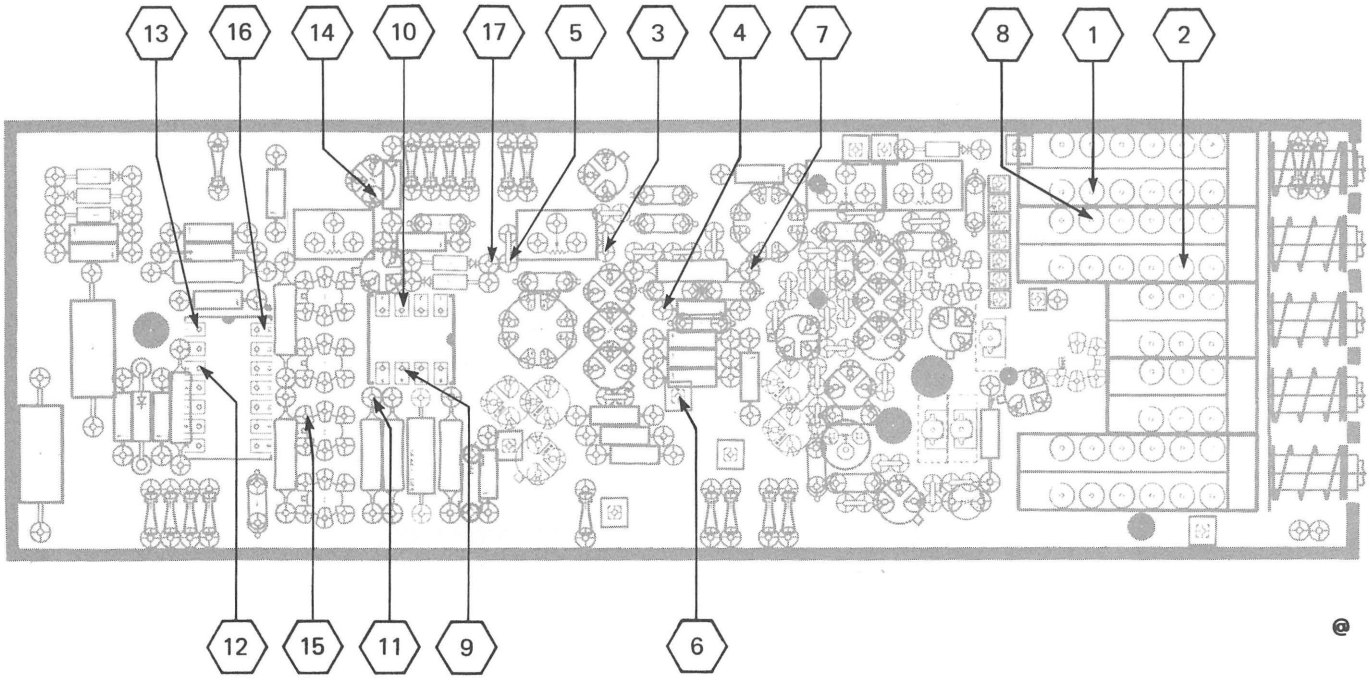
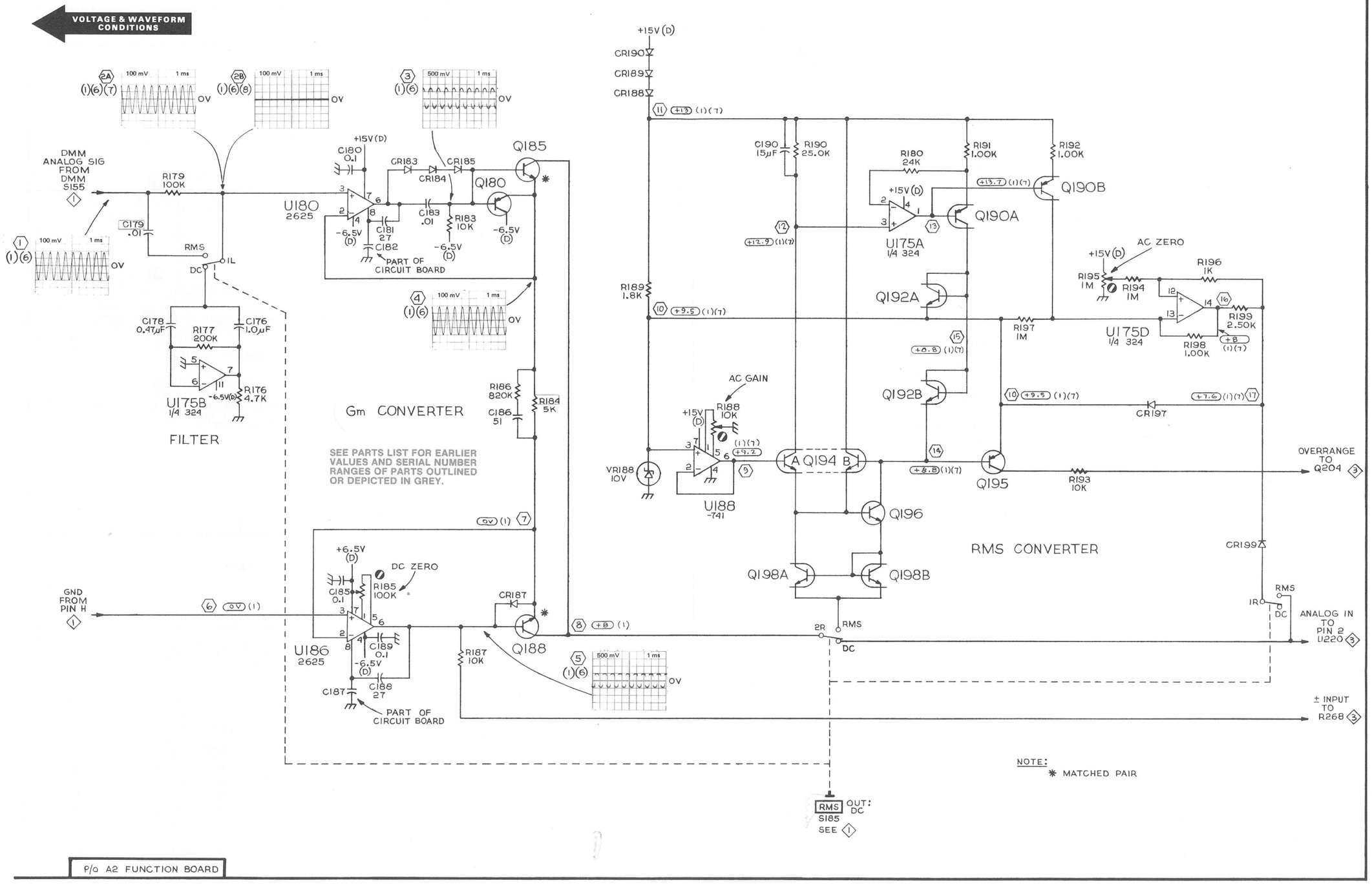



**Fig. 9-11. A2 Function circuit board voltage and waveform test points.**

VOLTAGE & WAVEFORM CONDITIONS




P/O A2 FUNCTION BOARD

# SPECIAL CONDITIONS

Special conditions are established after all controls are set as specified in 213 CONTROL SETTINGS on the VOLTAGE AND WAVEFORM CONDITIONS pullout page.

(1) DMM mode of operation.

(3) Set Volts-mA/DIV to 100 kΩ; Ω button in; connect a 100 kΩ, 0.1% resistor for measurement.

(6) Input is a 4 V p-p sine wave at 1 kHz; INPUT COUPLING is AC.

(7) RMS button in.

(8) Overrange indication is displayed.

(9) Test oscilloscope is externally triggered on pin 1 of U260.

(10) For voltages at test points (11), (12), (13), and (14), see Table 9-2.

## 4-DECADE COUNTER AND CHARACTER GENERATOR CHECK

Set up the calibration procedure for the Character Generator Check. Establish the logic HI and LO for pins 10, 11, 12, and 13 of U260 (A logic HI should exist at each pin when the INPUT COUPLING is set to GND, and 0's should be displayed. Establish the logic LO by setting the dc signal source for the display character that has a logic LO at the pin being measured. The character being displayed should appear in only one position and the other positions should display 0's.) Select a VOLTS-mA/DIV switch setting that will display the character being checked in only one position with 0's in the other positions. Change the signal source to display each of the characters and check the logic levels at pins 10, 11, 12, and 13. Voltages shown are typical.

TABLE 9-2

4-Decade Counter and Character Generator Check

| Display Character | Pin 9 (HI +4.3 V/ LO +3.5 V) | Pin 10 (HI +4.3 V/ LO +3.5 V) | Pin 11 (HI +3.2 V/ LO +2.4 V) | Pin 12 (HI +3.2 V/ LO +2.4 V) |
|---|---|---|---|---|
| 0 | HI | HI | HI | HI |
| 1 | LO | HI | HI | HI |
| 2 | HI | LO | HI | HI |
| 3 | LO | LO | HI | HI |
| 4 | HI | HI | LO | HI |
| 5 | LO | HI | LO | HI |
| 6 | HI | LO | LO | HI |
| 7 | LO | LO | LO | HI |
| 8 | HI | HI | HI | LO |
| 9 | LO | HI | HI | LO |



MORE

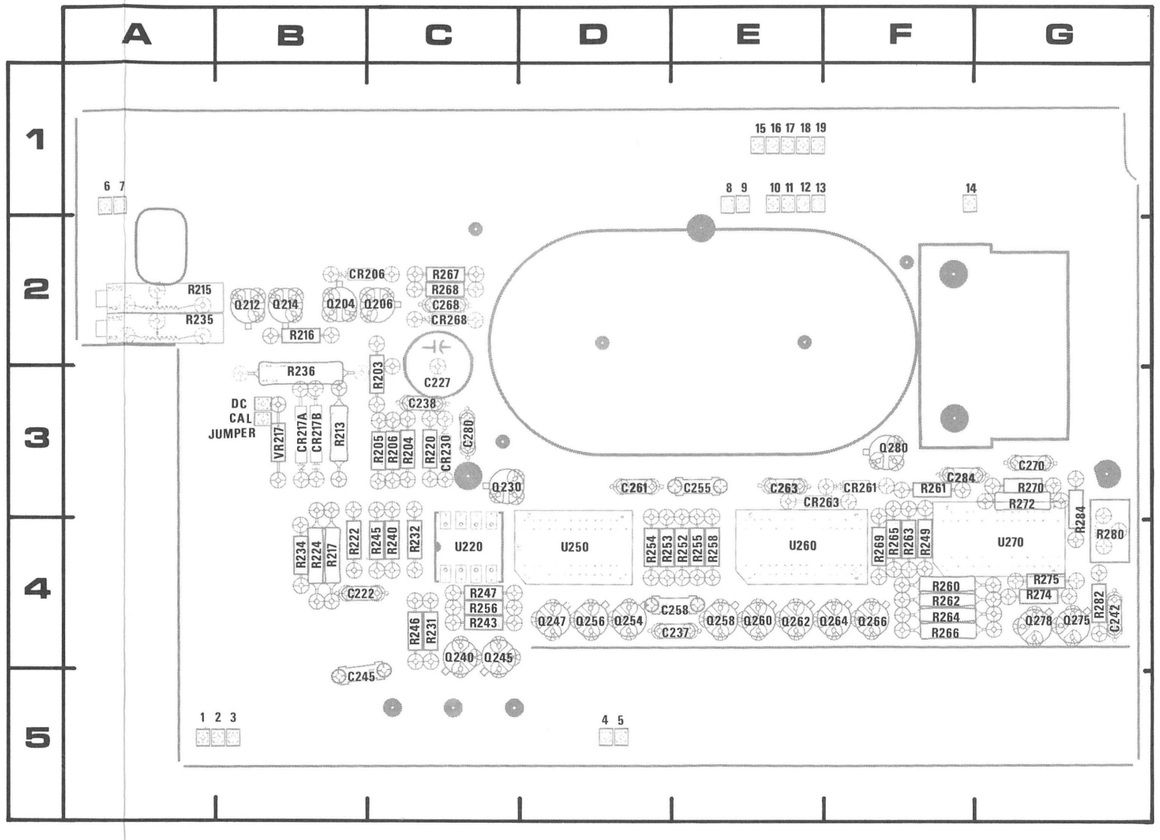



Fig. 9-12A. A3 A/D Converter circuit board (late SN version).

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|
| C222 | 4B | Q204 | 2B | R205 | 3C | R253 | 4D | R282 | 4G |
| C227 | 3C | Q206 | 2C | R206 | 3C | R254 | 4D | R284 | 3G |
| C237 | 4E | Q212 | 2B | R213 | 3B | R255 | 4E | | |
| C238 | 3C | Q214 | 2B | R215 | 2A | R256 | 4C | U220 | 4C |
| C242 | 4G | Q230 | 3C | R216 | 2B | R258 | 4E | U250 | 4D |
| C245 | 5B | Q240 | 4C | R217 | 4B | R260 | 4F | U260 | 4E |
| C255 | 3E | Q245 | 4C | R220 | 3C | R261 | 3F | U270 | 4G |
| C258 | 4E | Q247 | 4D | R222 | 4B | R262 | 4F | | |
| C261 | 3D | Q254 | 4D | R224 | 4B | R263 | 4F | VR217 | 3B |
| C263 | 3E | Q256 | 4D | R231 | 4C | R264 | 4F | | |
| C268 | 2C | Q258 | 4E | R232 | 4C | R265 | 4F | | |
| C270 | 3G | Q260 | 4E | R234 | 4B | R266 | 4F | | |
| C280 | 3C | Q262 | 4E | R235 | 2A | R267 | 2C | | |
| C284 | 3F | Q264 | 4F | R236 | 3B | R268 | 2C | | |
| | | Q266 | 4F | R240 | 4C | R269 | 4F | | |
| CR206 | 2C | Q275 | 4G | R243 | 4C | R270 | 3G | | |
| CR217A | 3B | Q278 | 4G | R245 | 4C | R272 | 3G | | |
| CR217B | 3B | Q280 | 3F | R246 | 4C | R274 | 4G | | |
| CR230 | 3C | | | R247 | 4C | R275 | 4G | | |
| CR261 | 3F | R203 | 3C | R249 | 4F | R280 | 4G | | |
| CR263 | 3F | R204 | 3C | R252 | 4E | | | | |
| CR268 | 2C | | | | | | | | |

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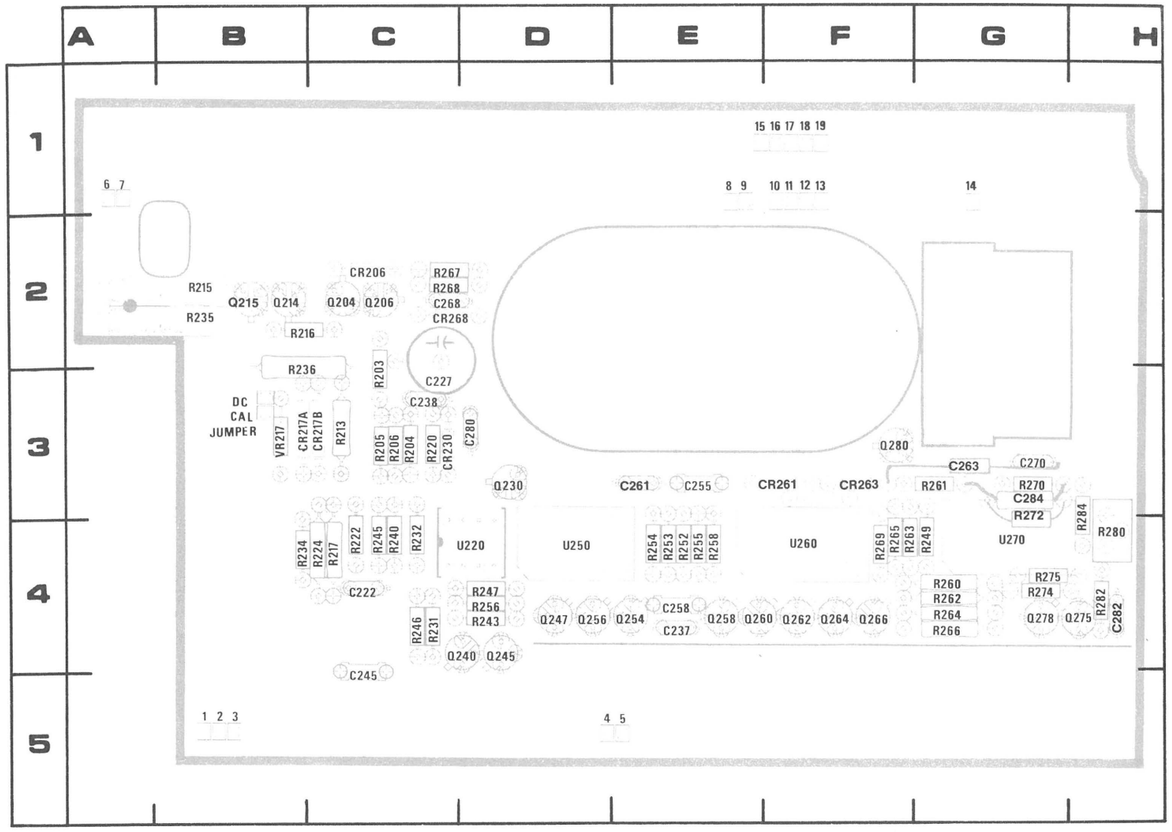



Fig. 9-12B. A3 A/D Converter circuit board (early SN version).

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|
| C222 | 4C | CR268 | 2C | R203 | 3C | R247 | 4D | R274 | 4G |
| C227 | 3C | | | R204 | 3C | R249 | 4G | R275 | 4G |
| C237 | 4E | Q204 | 2C | R205 | 3C | R252 | 4E | R280 | 4H |
| C238 | 3C | Q206 | 2C | R206 | 3C | R253 | 4E | R282 | 4H |
| C245 | 5C | Q214 | 2B | R213 | 3C | R254 | 4E | R284 | 3H |
| C255 | 3E | Q215 | 2B | R215 | 2B | R255 | 4E | | |
| C258 | 4E | Q230 | 3D | R216 | 2B | R256 | 4D | U220 | 4D |
| C261 | 3E | Q240 | 4D | R217 | 4C | R258 | 4E | U250 | 4D |
| C263 | 3G | Q245 | 4D | R220 | 3C | R260 | 4G | U260 | 4F |
| C268 | 2C | Q247 | 4D | R222 | 4C | R261 | 3G | U270 | 4G |
| C270 | 3G | Q254 | 4E | R224 | 4C | R262 | 4G | | |
| C280 | 3D | Q256 | 4D | R231 | 4C | R263 | 4F | VR217 | 3B |
| C282 | 4H | Q258 | 4E | R232 | 4C | R264 | 4G | | |
| C284 | 3G | Q260 | 4E | R234 | 4B | R265 | 4F | | |
| | | Q262 | 4F | R235 | 2B | R266 | 4G | | |
| CR206 | 2C | Q264 | 4F | R236 | 3B | R267 | 2C | | |
| CR217A | 3B | Q266 | 4F | R240 | 4C | R268 | 2C | | |
| CR217B | 3C | Q275 | 4H | R243 | 4D | R269 | 4F | | |
| CR230 | 3C | Q278 | 4G | R245 | 4C | R270 | 3G | | |
| CR261 | 3F | Q280 | 3F | R246 | 4C | R272 | 3G | | |
| CR263 | 3F | | | | | | | | |

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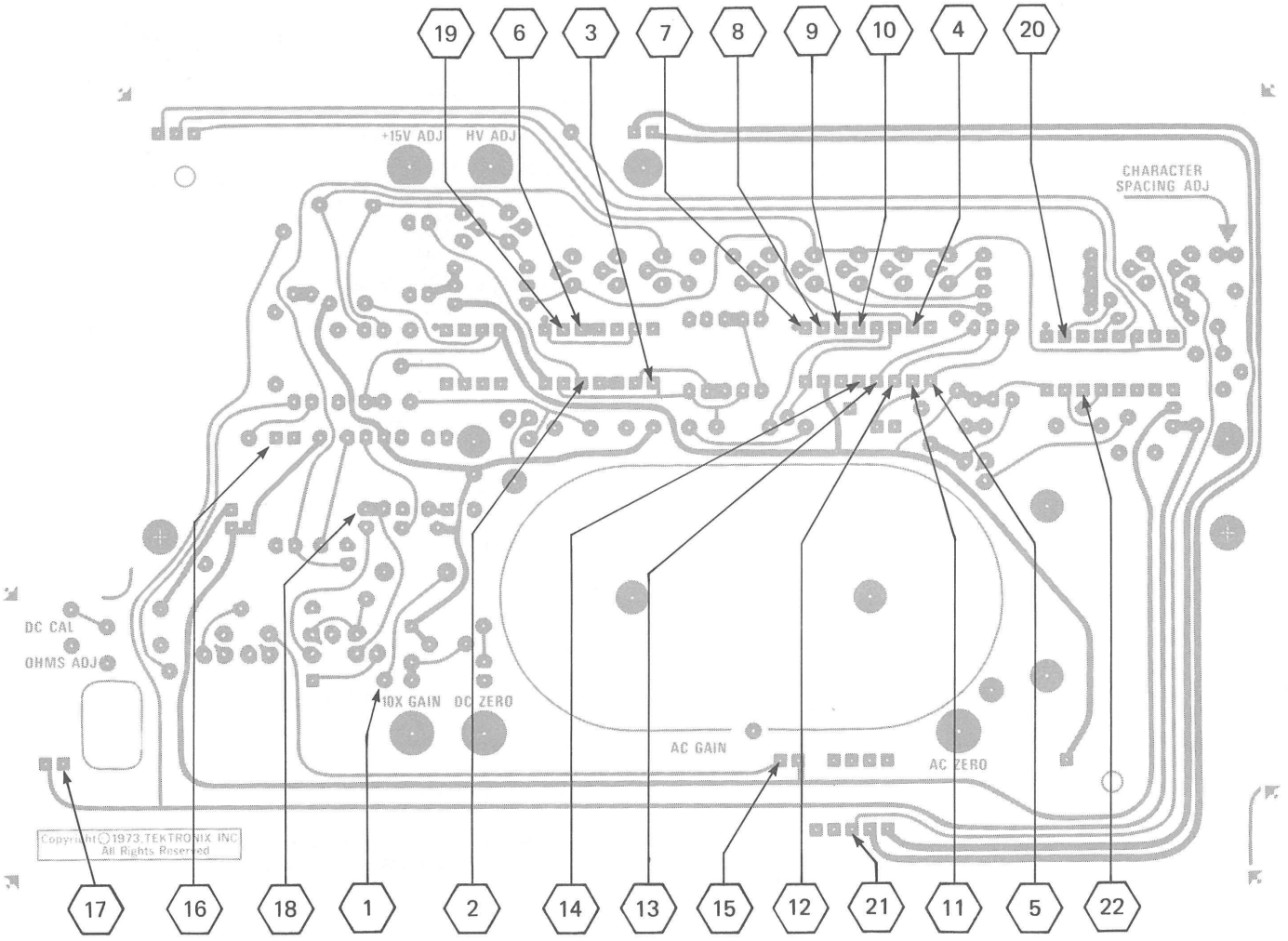
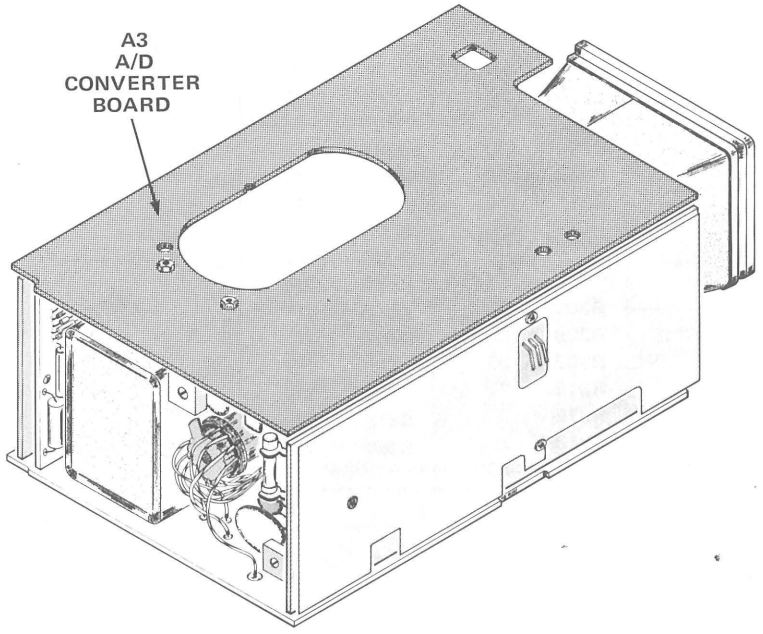
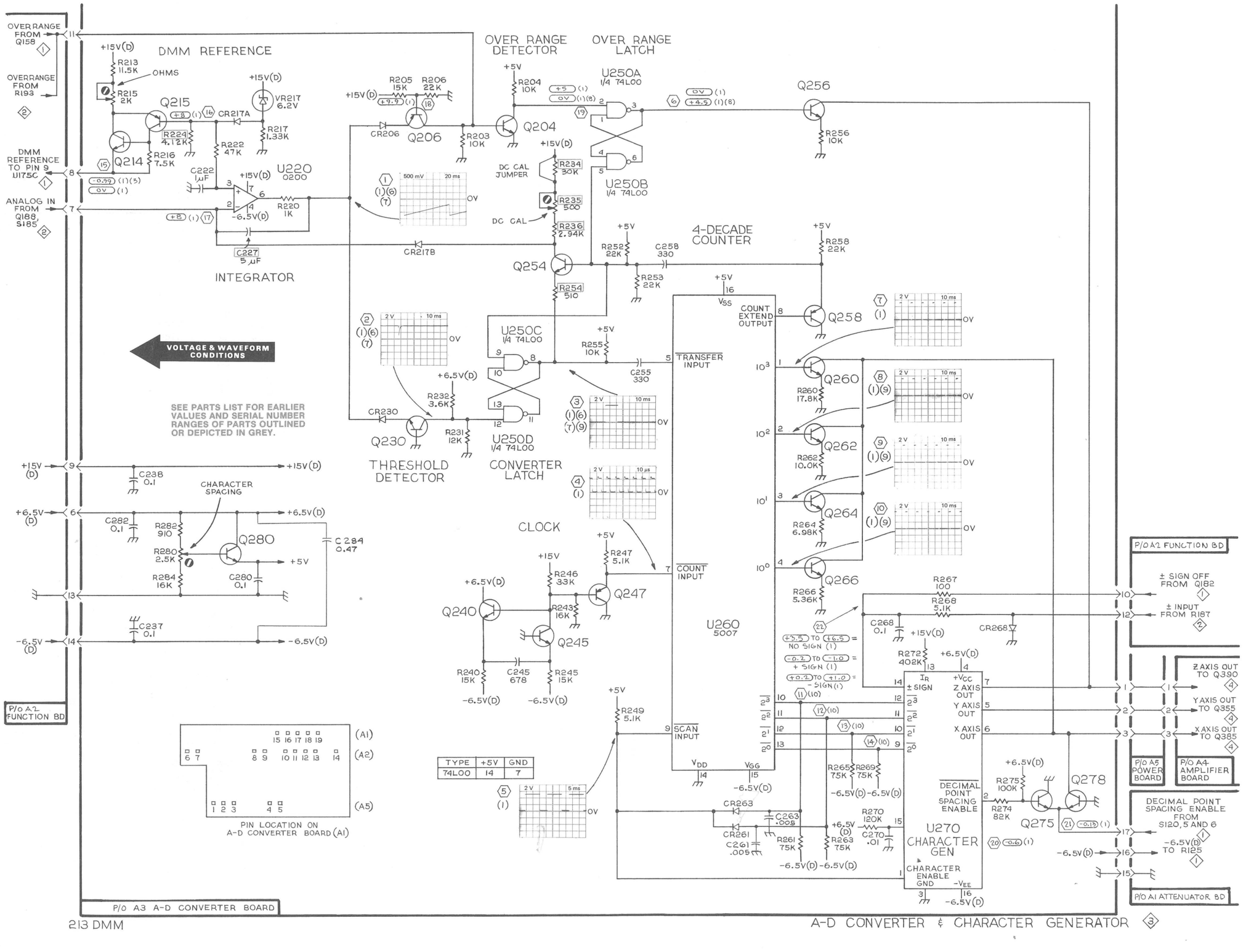



**Fig. 9-13. A3 A/D Converter circuit board voltage and waveform test points.**






213 DMM

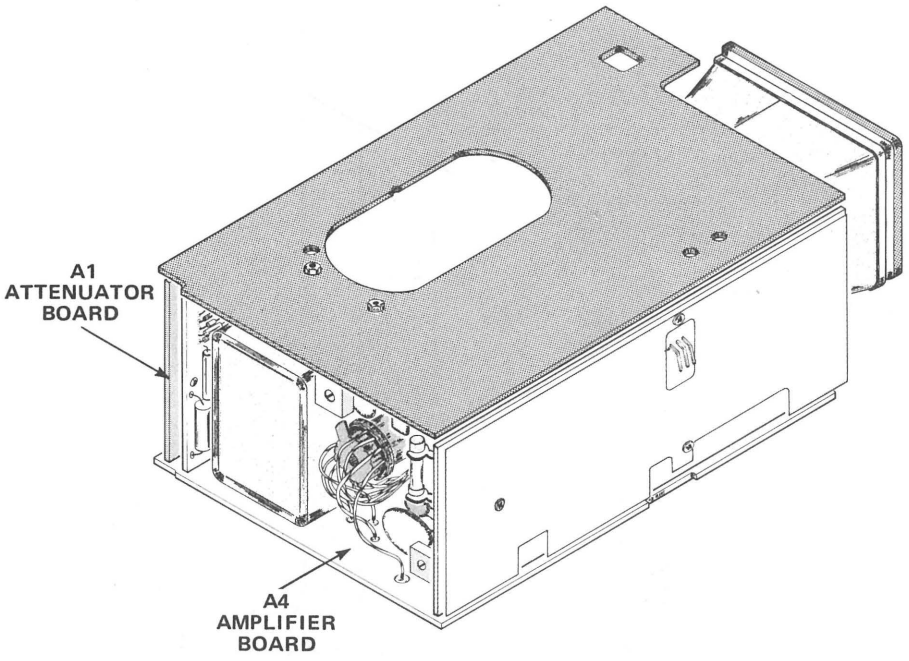
A-D CONVERTER & CHARACTER GENERATOR ◇3

# SPECIAL CONDITIONS

Special conditions are established after all controls are set as specified in 213 CONTROL SETTINGS on the VOLTAGE AND WAVEFORM CONDITIONS pullout page:

(2) Oscilloscope mode of operation.

(5) Input is a positive 4 V peak pulse at 1 kHz with a duty cycle of 20%; INPUT COUPLING is AC. Pattern centered vertically.

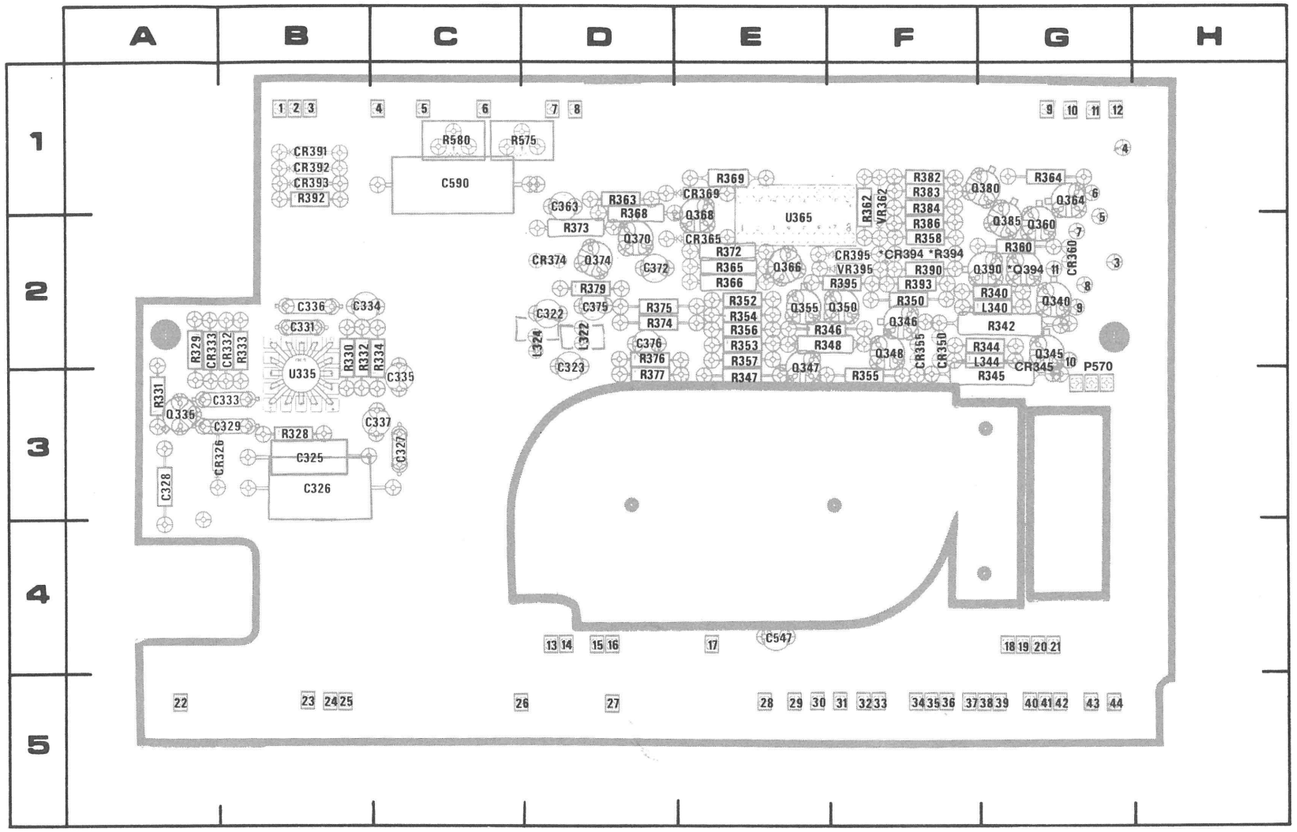





MORE

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|
| C322 | 2D | CR392 | 1B | R329* | 3A | R374 | 2D |
| C323 | 3D | CR393 | 1B | R330 | 3B | R375 | 2D |
| C325 | 3B | CR394* | 2F | R331* | 3A | R376 | 3D |
| C326 | 3B | CR395 | 2F | R332 | 3B | R377 | 3D |
| C327 | 3C | | | R333 | 3B | R379 | 2D |
| C328 | 4A | L322 | 3D | R334 | 3C | R382 | 1F |
| C329 | 3A | L324 | 3D | R340 | 2G | R383 | 2F |
| C331 | 2B | L340 | 2G | R342 | 2G | R384 | 2F |
| C333 | 3A | L344 | 3F | R344 | 3F | R386 | 2F |
| C334 | 2B | P570 | 3G | R345 | 3G | R390 | 2F |
| C335 | 3C | | | R346 | 2E | R392 | 2B |
| C336 | 2B | Q335* | 3A | R347 | 3E | R393 | 2F |
| C337 | 3B | Q340 | 2G | R348 | 3E | R394* | 2F |
| C338*† | | Q345 | 3G | R350 | 2F | R395 | 2F |
| C363 | 2D | Q346 | 2F | R352 | 2E | R575 | 1C |
| C372 | 2D | Q347 | 3E | R353 | 3E | R580 | 1C |
| C375 | 2D | Q348 | 3F | R354 | 2E | | |
| C376 | 3D | Q350 | 2F | R355 | 3F | U335 | 3B |
| C547 | 4E | Q355 | 2E | R356 | 2E | U365 | 2E |
| C590 | 1C | Q360 | 2G | R357 | 3E | | |
| CR326 | 3A | Q364 | 2G | R358 | 2F | VR362 | 2F |
| CR332 | 3B | Q366 | 2E | R360 | 2G | VR395 | 2F |
| CR333 | 3B | Q368 | 2E | R362 | 2F | | |
| CR345*† | | Q370 | 2D | R363 | 2D | | |
| CR350 | 3F | Q374 | 2D | R364 | 1G | | |
| CR355 | 3F | Q380 | 2F | R365 | 2E | | |
| CR360 | 2G | Q385 | 2G | R366 | 2E | | |
| CR365 | 2E | Q390 | 2G | R368 | 2D | | |
| CR369 | 2E | Q394* | 2G | R369 | 1E | | |
| CR374 | 2D | | | R372 | 2E | | |
| CR391 | 1B | R328 | 3B | R373 | 2D | | |

*See parts list for serial number ranges.




† C338 & CR345 located on back of board.

Fig. 9-14. A4 Amplifier circuit board.

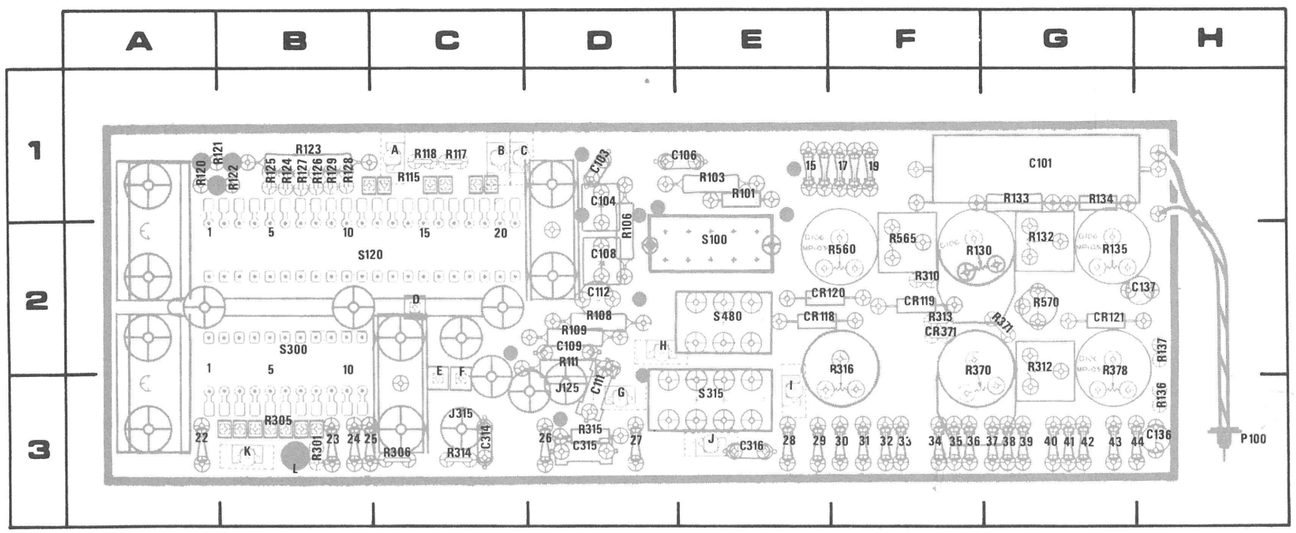



Fig. 9-15. A1 Attenuator circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|
| C314 | 3C | R315 | 3D |
| C315 | 3D | R316 | 2F |
| C316 | 3E | R370 | 2F |
| CR371 | 2F | R371 | 2G |
| J315 | 3C | R378 | 2G |
| R301 | 3B | R560 | 2F |
| R305 | 3B | R565 | 2F |
| R306 | 3C | R570 | 2G |
| R310 | 2F | S300 | 2B |
| R312 | 2G | S315 | 3E |
| R313 | 2F | S480 | 2E |
| R314 | 3C | | |

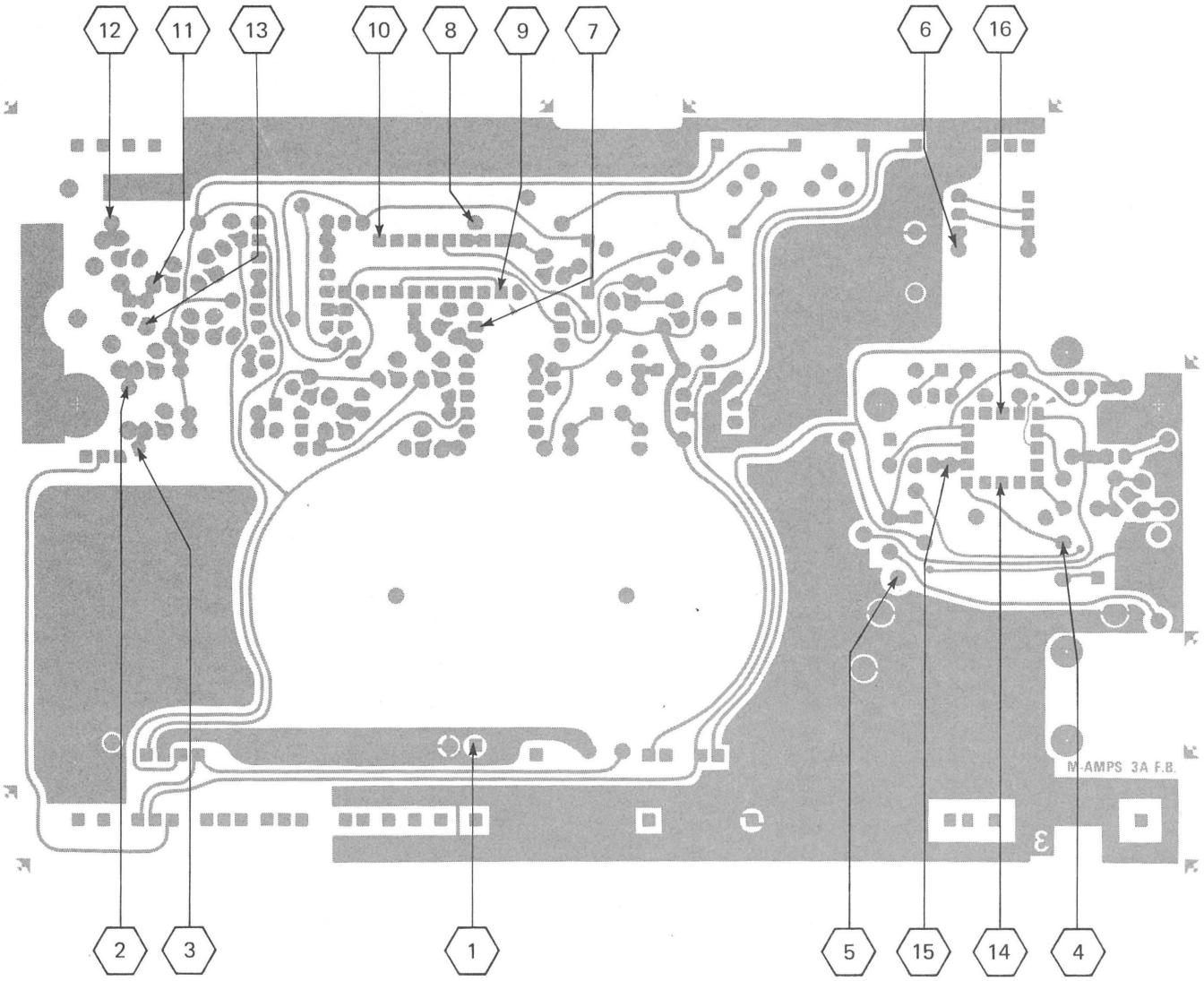



Fig. 9-16. A4 Amplifier circuit board voltage and waveform test points.

**VOLTAGE & WAVEFORM CONDITIONS**

4 (2): 20 mV, 2 ms, -13mV

5 (2): 20, 2 ms, -1.3

6 (2): 1 V, 2 ms, +6.5

7 (2): 50 mV, 2 ms, +6

8 (2): 500 mV, 2 ms, +5

9 (2): 50 mV, 2 ms, +7.5

10 (2): 500 mV, 2 ms, +7.5

13 (2): 20 V, 2 ms, +44

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

P/O A2 FUNCTION BOARD

VERT SIGNAL FROM Q174 (1)

(SWITH SHOWN IN 2µS) SEC/DIV S300: 2 5 10 20 50 .1 .2 .5 µS; 2 5 10 20 50 .1 .2 .5 mS; SEC

R301 10.0K; R305: 50K 50K 100K 300K 500K 1M; R306 3.0M

+15V, +6.5V(D), +6.5V(S), +6.5V, -6.5V(S), -6.5V, -6.5V(D)

VR362 7.5V; R362 3.0K; L322 64µH; L324 64µH; C322 33µF; C323 33µF; C335 2.2µF; C375 2.2µF; R374 88.7K; Q374; CR374; R375 10.0K; -3.6V; -6.5V(S)

PIN LOCATION ON AMPLIFIER BOARD (A4)

(A5): 1 2 3 4 5 6 7 8 9 10 11 12

(A2): 13 14 15 16 17 18 19 20 21

(A1): 22 24 26 28 30 32 34 36 38 40 42 44 / 23 25 27 29 31 33 35 37 39 41 43

SWEEP GEN

C327 .001; C328 0.47; R329; C337 2.2µF; C338 87; CR326; C326 1.0µF; C325 .001

U335: Vcc, MILLER OUT, MILLER IN, INPUT AMP, TIME VOLT, SWEEP H-O, SWEEP MULTI, TRIG LVL SLP, SWEEP CAL, SWEEP LENGTH, UN-BLANK, TRIG IN, TRIGGER, FREE RUN HOLDOFF, GND, -VEE

R328 4.7K; R331; Q335; R316 10K; TRIGGER LEVEL-SLOPE; C333 .022; R310 51K; R312 50K; SWP CAL; R313 51K; C329 .01; R330 16K; R332 20K; (-1.4) (2); (+5) (2)

VERT SIGNAL FROM Q174 (1); C316 0.1; INT AC; NORMAL EXT DC; AUTO; EXT TRIG; J315; R314 910K; C314 16.8pF; R315 110K; C315 150; TRIGGER S315

CR332; CR333; CR326; R333 1M; C331 25; C334 1.µF; R334 10K; C336 .01; -5V(2Ø); (-4.3) (EXT & NORM); (+6.2) (AUTO)

P/O A1 ATTENUATOR BD

P/O A1 ATTENUATOR BD: +6.5V, R371 5.6K, CR371, R370 5K (DETENT), HORIZ MGF VAR, POS, R378 20K, -6.5V; R379 5.6K; C372 2.2µF; R373 953; R377 18K; C376 2.2µF; R376 5.6K; R369 22K; +15V

VERTICAL OUTPUT AMP

+15V, R350 18K, Q346, R346 274, R348 274, Q347, -3.6V, R347 464, -6.5V(S), Q348, R355 18K, +15V

+6.5V(D), R357 680, Q350, R352 510, R353 5.6K, -6.5V (D), R354 150, R356 3K, Q355

CR355, CR350

+7.5V, CR345, Q345, R345 15.0K, L344 820µH, R344 39K, +75V

L340 820µH, R340 39K, R342 15.0K, +75V

-VERT SIGNAL TO LOWER PLATE PIN 9, V560

+VERT SIGNAL TO UPPER PLATE PIN 10, V560

TO VERTICAL DEFLECTION PLATES (6)

HORIZONTAL OUTPUT AMP

FROM (3): Y AXIS OUT FROM U270-5 THRU PIN2; X AXIS OUT FROM U270-6 THRU PIN3

R358 2.2K; +6.5V(D), R386 750

+15V, R365 22K, Q366, CR365, +6.5V, R366 931

Q385, R384 75, R383 10K, R382 560, Q380, +6.5V (D)

Q360, CR360, R360 44.2K, +HORIZ SIGNAL TO RIGHT PLATE PIN 7, V560

Q364, R364 44.2K, -HORIZ SIGNAL TO LEFT PLATE PIN 6, V560

TO HORIZONTAL DEFLECTION PLATES (6)

U365 -259

Z AXIS AMP

Q394, R390 56K, R394 10K, CR394, R395 470K, CR395, VR395 47V, Q390, R393 180K, CR391, CR392, CR393, R392 100K, +6.5V

UNBLANKING SIGNAL TO PIN 11, V560 (6)

FROM (3): Z AXIS OUT FROM U270-7 THRU PIN3

NOTE: * MATCHED PAIR.

P/O A4 AMPLIFIER BOARD

REV SEP 1984

VERTICAL & HORIZONTAL AMPLIFIERS & SWEEP GENERATOR (4)

213 DMM

# SPECIAL CONDITIONS

**CAUTION**

*When making voltage and waveform measurements on the Battery Charger Converter (A6 Secondary Power Supply circuit board), be sure to connect an isolation transformer between the instrument power plug and the power line to prevent instrument damage.*

Special conditions are established after all controls are set as specified in 213 CONTROL SETTINGS on the VOLTAGE AND WAVEFORM CONDITIONS pullout page.

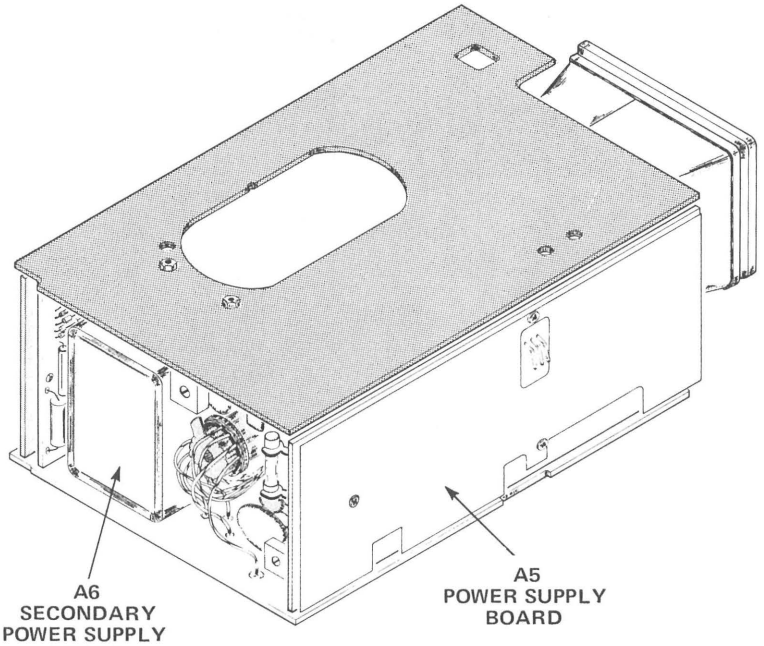
(1) DMM mode of operation.

(2) Battery charger is operating.

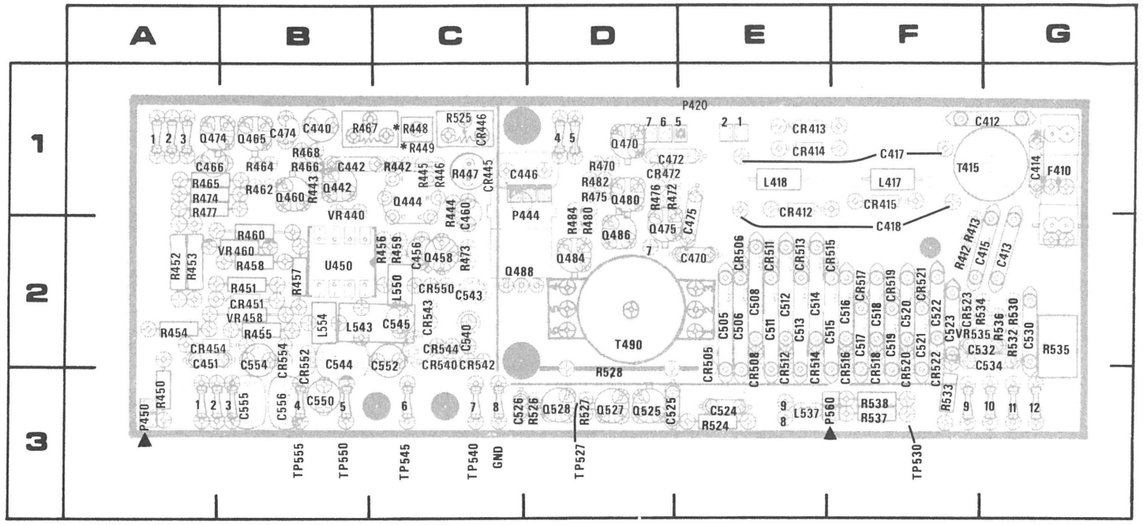
(3) POWER switch is ON; battery charged; instrument is operating normally.

(4) POWER switch is ON; battery is discharged; instrument is off due to low voltage shutdown.

(5) The common lead of the test oscilloscope must be connected to test point A.




MORE




*See Parts List for serial number ranges.

Fig. 9-17. A5 Power Supply circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C412 | 1G | C472 | 1D | F410 | 1G | Q470 | 1D | R446 | 1C | R460 | 2B | R480 | 2D |
| C413 | 2G | C474 | 1B | | | Q474 | 1A | R447 | 1C | R462 | 1B | R482 | 1D |
| C414 | 1G | C475 | 2E | L417 | 1F | Q475 | 2D | *R448 | 1C | R464 | 1B | R484 | 2D |
| C415 | 2G | | | L418 | 1E | Q480 | 1D | *R449 | 1C | R465 | 1A | | |
| C417 | 1F | CR412 | 1E | | | Q484 | 2D | R450 | 1C | R466 | 1B | T415 | 1F |
| C418 | 2F | CR413 | 1E | P444 | 2D | Q486 | 2D | R451 | 2B | R467 | 1B | T490 | 2D |
| C440 | 1B | CR414 | 1E | P450 | 3A | Q488 | 2C | R452 | 2A | R468 | 1B | | |
| C442 | 1B | CR415 | 1F | P560 | 3F | | | R453 | 2A | R470 | 1D | U450 | 2B |
| C446 | 1C | CR445 | 1C | | | R412 | 2F | R454 | 2A | R472 | 1D | | |
| C451 | 2A | CR446 | 1C | Q442 | 1B | R413 | 2F | R455 | 2B | R473 | 2C | VR440 | 2B |
| C456 | 2C | CR451 | 2B | Q444 | 1C | R442 | 1C | R456 | 2C | R474 | 1A | VR458 | 2B |
| C460 | 2C | CR454 | 2A | Q458 | 2C | R443 | 1B | R457 | 2B | R475 | 1D | VR460 | 2B |
| C466 | 1A | CR472 | 1D | Q460 | 1B | R444 | 1C | R458 | 2B | R476 | 1D | | |
| C470 | 2E | | | Q465 | 1B | R445 | 1C | R459 | 2C | R477 | 1A | | |

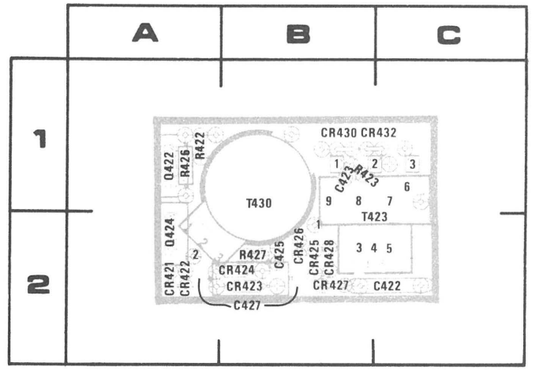



Fig. 9-18. A6 Secondary Power Supply circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|
| C422 | 2C | CR425 | 2B | R422 | 1A |
| C423 | 1B | CR426 | 2B | R423 | 1B |
| C425 | 2B | CR427 | 2B | R426 | 1A |
| C427 | 2B | CR428 | 2B | R427 | 2B |
| | | CR430 | 1B | | |
| CR421 | 2A | CR432 | 1C | T423 | 2B |
| CR422 | 2A | | | T430 | 1B |
| CR423 | 2B | Q422 | 1A | | |
| CR424 | 2B | Q424 | 2A | | |

Refer to Fig. 9-15 for A1 Attenuator circuit board components.

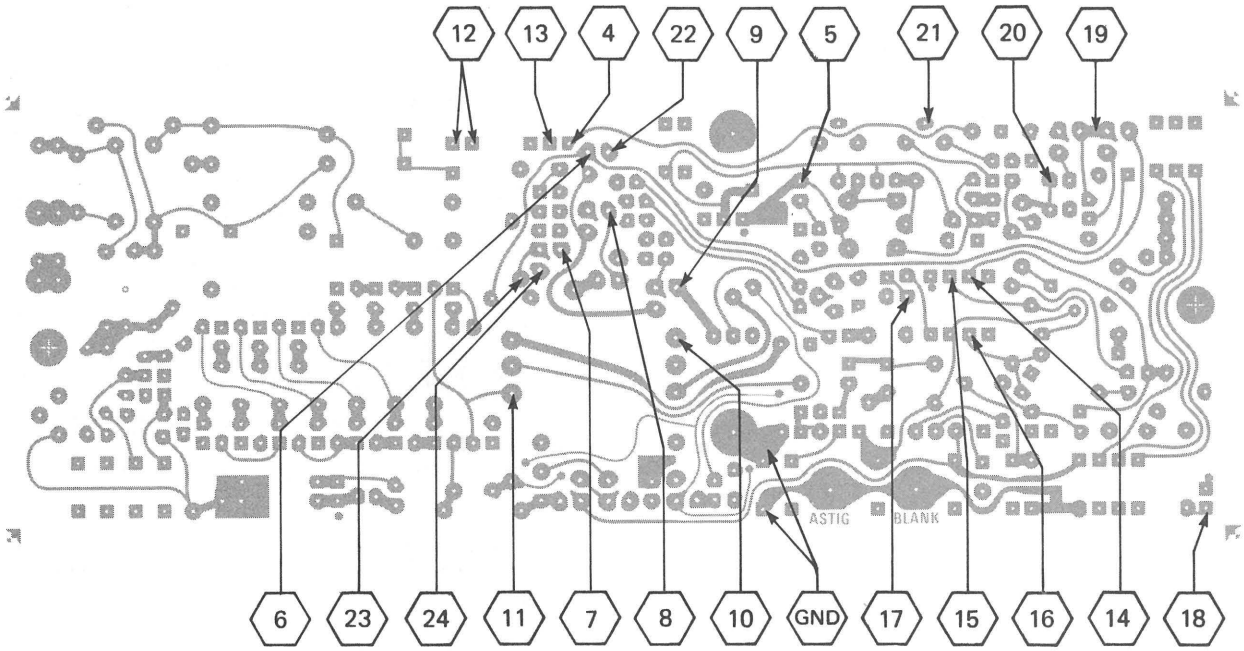



Fig. 9-19. A5 Power Supply circuit board voltage and waveform test points.

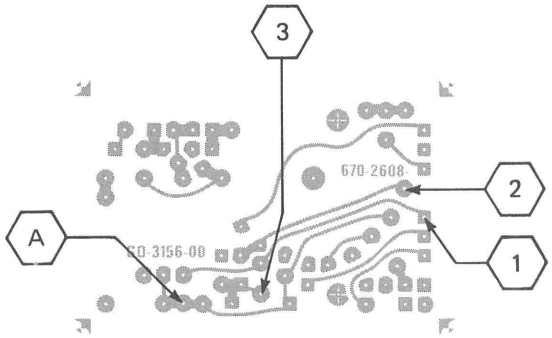
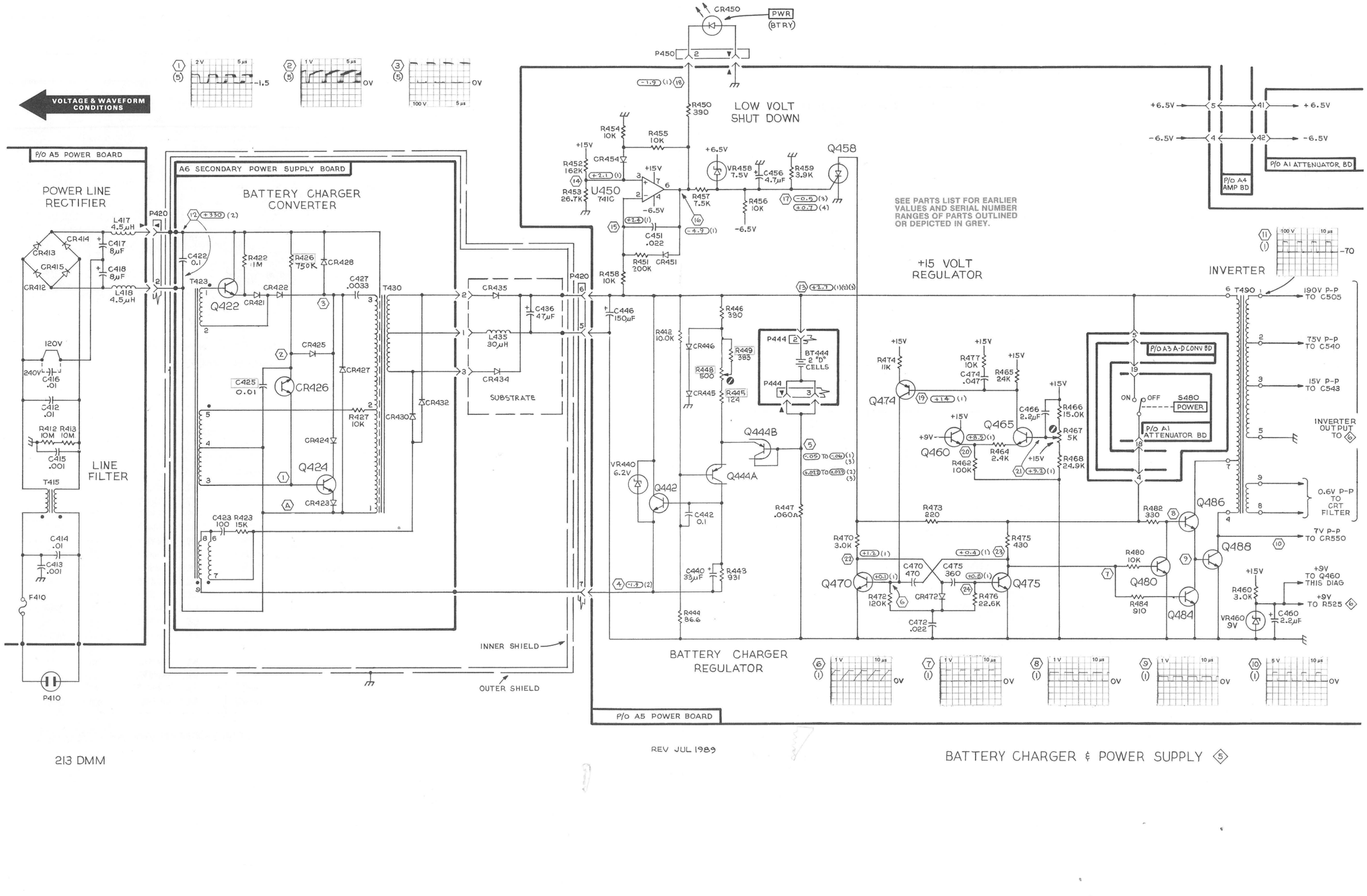



Fig. 9-20. A6 Secondary Power Supply circuit board voltage and waveform test points.




213 DMM

REV JUL 1989

BATTERY CHARGER & POWER SUPPLY (5)

# SPECIAL CONDITIONS

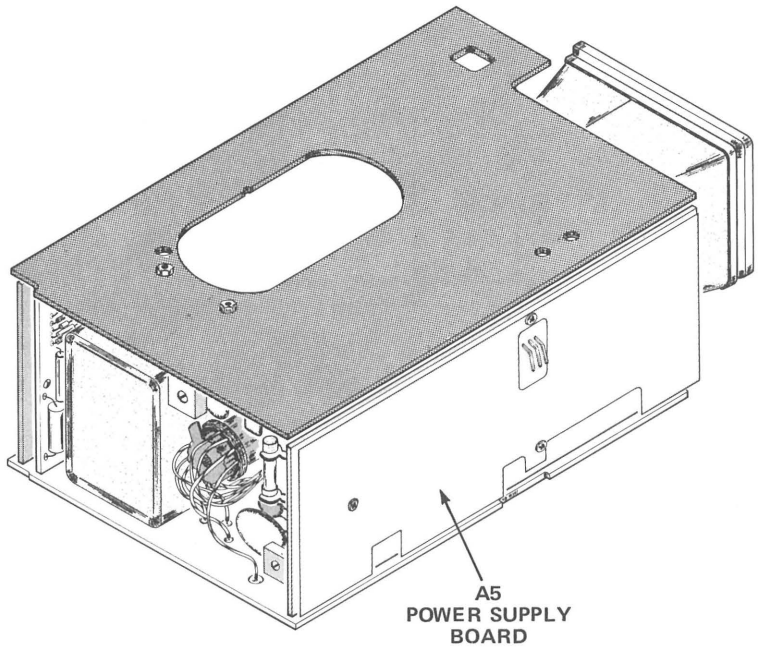
Special conditions are established after all controls are set as specified in 213 CONTROL SETTINGS on the VOLTAGE AND WAVEFORM CONDITIONS pullout page.

(1) Oscilloscope mode of operation.

**TABLE 9-3**
**Typical High Voltage Multiplier Voltages**

| Measurement Location | Test Point | Typical Voltage (Vdc) |
|---|---|---|
| Across C506 | 12 | 190 |
| Across C511 | 13 | 185 |
| Across C513 | 14 | 185 |
| Across C515 | 15 | 185 |
| Across C523 | 16 | 175 |
| From junction of C515 & C519 to junction of C517 and C521 | 17 | 180 |
| From junction of C517 & C521 to junction of C519 and CR519/CR520 | 18 | 180 |
| From junction of C519 and CR519/CR520 to junction of C521 and C523 | 19 | 170 |

@




MORE

Refer to Fig. 9-14 for A4 Amplifier circuit board components.

Refer to Fig. 9-15 for A1 Attenuator circuit board components.

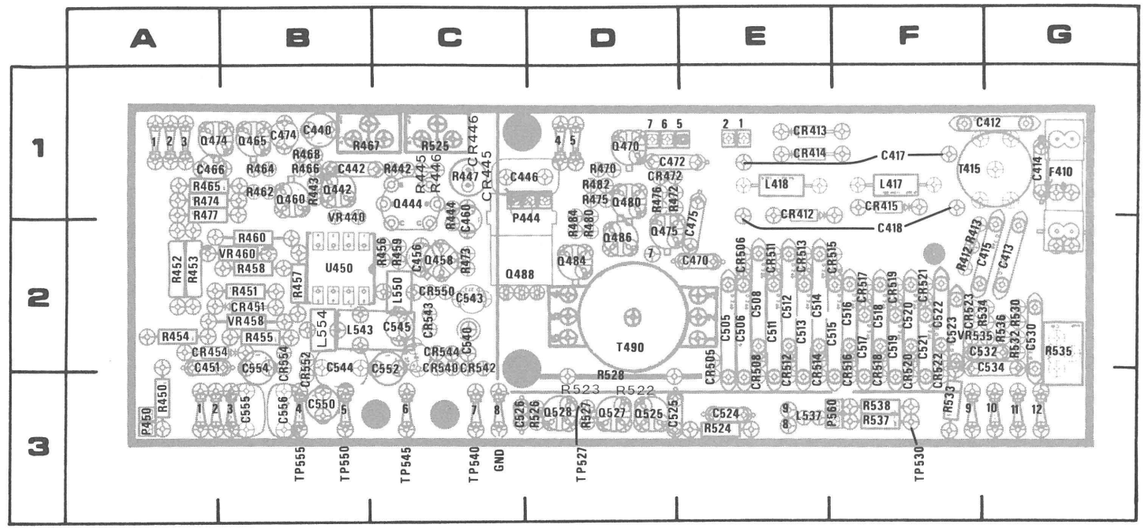



Fig. 9-21. A5 Power Supply circuit board.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|
| C505 | 2E | C526 | 3C | CR512 | 2E | CR554 | 2B | R528 | 3D |
| C506 | 2E | C530 | 2G | CR513 | 2E | L537 | 3E | R530 | 2G |
| C508 | 2E | C532 | 2F | CR514 | 2E | L543 | 2B | R532 | 2G |
| C511 | 2E | C534 | 2G | CR515 | 2F | L550 | 2C | R533 | 3F |
| C512 | 2E | C540 | 2C | CR516 | 2F | L554 | 2B | R534 | 3G |
| C513 | 2E | C543 | 2C | CR517 | 2F | P560 | 3F | R535 | 2G |
| C514 | 2E | C544 | 2B | CR518 | 2F | Q525 | 3D | R536 | 2G |
| C515 | 2E | C545 | 2C | CR519 | 2F | Q527 | 3D | R537 | 3F |
| C516 | 2F | C550 | 3B | CR520 | 2F | Q528 | 3D | R538 | 3F |
| C517 | 2F | C552 | 2C | CR521 | 2F | R442 | 1C | TP527 | 3D |
| C518 | 2F | C554 | 2B | CR522 | 2F | R522 | 3D | TP530 | 3F |
| C519 | 2F | C555 | 3B | CR523 | 2F | R523 | 3D | TP540 | 3C |
| C520 | 2F | C556 | 3B | CR540 | 2C | R524 | 3E | TP545 | 3C |
| C521 | 2F | | | CR542 | 2C | R525 | 1C | TP550 | 3B |
| C522 | 2F | CR505 | 2E | CR543 | 2C | R526 | 3D | TP555 | 3B |
| C523 | 2F | CR506 | 2E | CR544 | 2C | R527 | 3D | | |
| C524 | 3E | CR508 | 2E | CR550 | 2C | | | VR535 | 2F |
| C525 | 3D | CR511 | 2E | CR552 | 2B | | | | |

R522 and R523 are located on back side of board.

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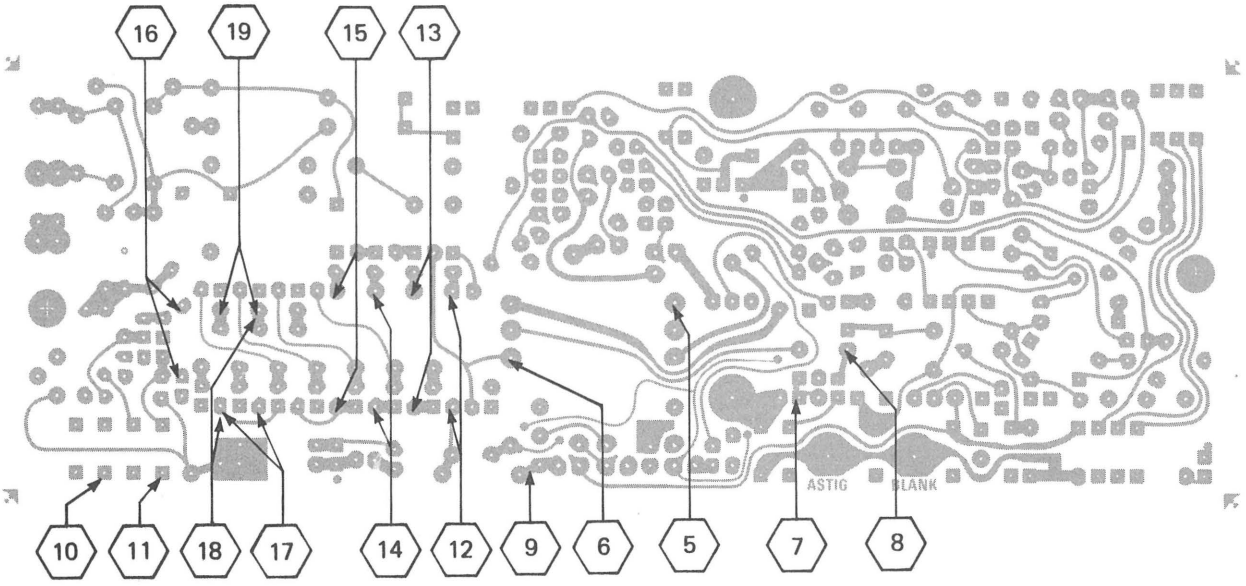



Fig. 9-22. A5 Power Supply circuit board voltage and waveform test points.

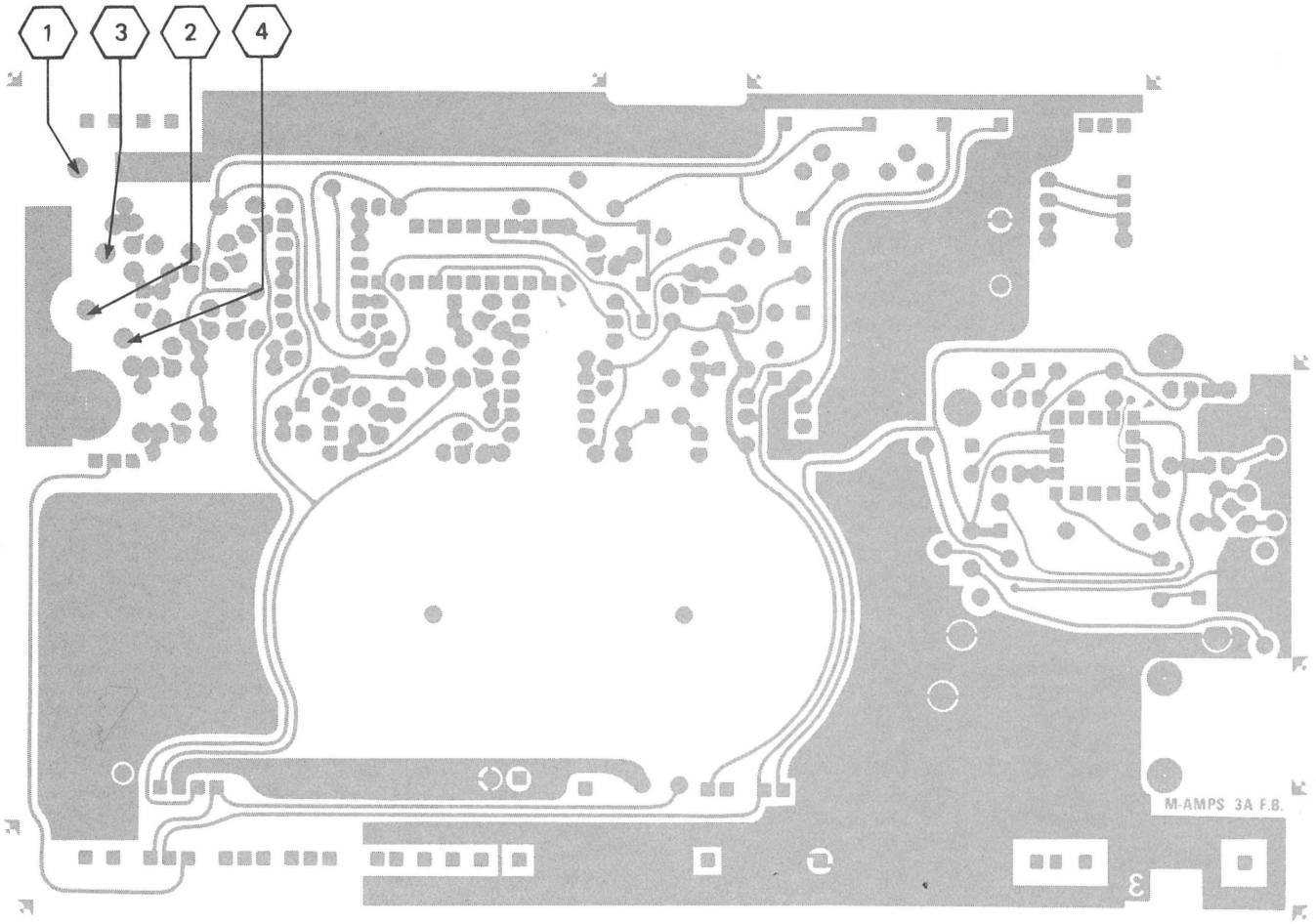



Fig. 9-23. A4 Amplifier circuit board voltage and waveform test points.

# H.V. REGULATOR

**VOLTAGE & WAVEFORM CONDITIONS**

INVERTER OUTPUT FROM T490 ⑤

190V P-P

⑥ (1)

100 V / 10 µs

-70

C505 .047 · C506 .047 · C508 .047 · C511 .047 · C512 .047 · C513 .047 · C514 .047 · C515 .047 · C516 .01 · C517 .01 · C518 .01 · C519 .01 · C520 .01 · C521 .01 · C522 .01 · C523 .01

CR505 · CR506 · CR508 · CR511 · CR512 · CR513 · CR514 · CR515 · CR516 · CR517 · CR518 · CR519 · CR520 · CR521 · CR522 · CR523

C524 .047

R524 20K

⑨ +219 ±20 (1)

Q525 · Q527 · Q528

C525 180pF

R522 6.2M · R523 2.7M · R526 499K · R527K 1K · R528 100M

TP527 0.28V

+9V

H.V

R525 1M

C526 .0015

NOTE:
FOR TYPICAL MULTIPLIER VOLTAGES SEE TABLE 9-3.

⑪ -800 (1)

C532 .005 · VR535 200V · R532 4.7M · R530 4.7M

R533 47K · C530 .01 · TP530 -1000V

GRID DRIVE

R535 500K · R536 270K · C534 .01

⑩ -1100 (1)

R534 330K

R537 10 · R538 10

L537 1.05µH

0.6V P-P

⑦ (1) 50 V / 10 µs OV

C540 1µF · CR542 · CR540

75V P-P

TP540 +75V

C543 15µF · CR544 · CR543

15V P-P

⑧ (1) 10 V / 10 µs OV

C544 68µF

L543 64µH · C545 15µF

TP545 +15V

7V P-P FROM COLL Q488 ⑤

⑤ (1) 5 V / 10 µs OV

C552 33µF · CR552 · CR550 · CR554

C550 33µF · L550 64µH · C555 100µF

C554 33µF · L554 64µH · C556 100µF

TP550 +6.5V

-6.5V TP555

P/O A5 POWER BOARD

P/O A1 ATTEN BD

FOCUS · R565 2M

INTENSITY · R560 2M

-730 ±70 (1) ①

P/O A4 AMP BD

-1033 ±33 (1) ②

P560

P570

L500

V560

CRT SHIELD

TRACE ROTATE · R570 20K · +6.5V · -6.5V

P/O A1 ATTENUATOR BOARD

10 (UPPER) · 9 (LOWER) — VERTICAL SIGNAL FROM ④

7 (RIGHT) · 6 (LEFT) — HORIZONTAL SIGNAL FROM ④

+75V · R575 200K · ASTIG

③ +62 (1)

⑧ +47 (1)

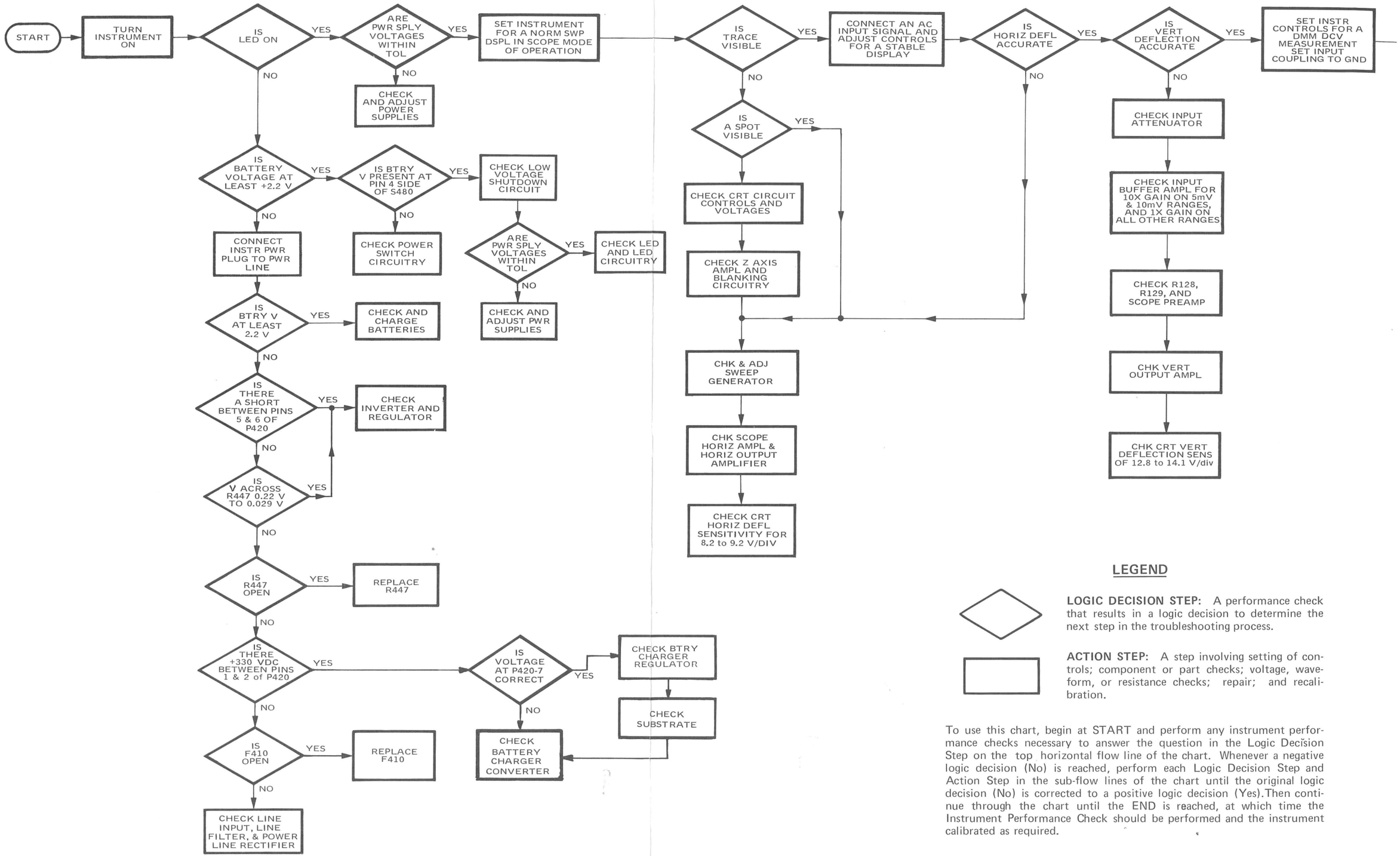
+75V · R580 100K · +15V · BLANK CENTER

UNBLANKING SIGNAL FROM Q394 ④

+75V · +15V · +6.5V · -6.5V

C590 10µF

P/O A4 AMPLIFIER BOARD



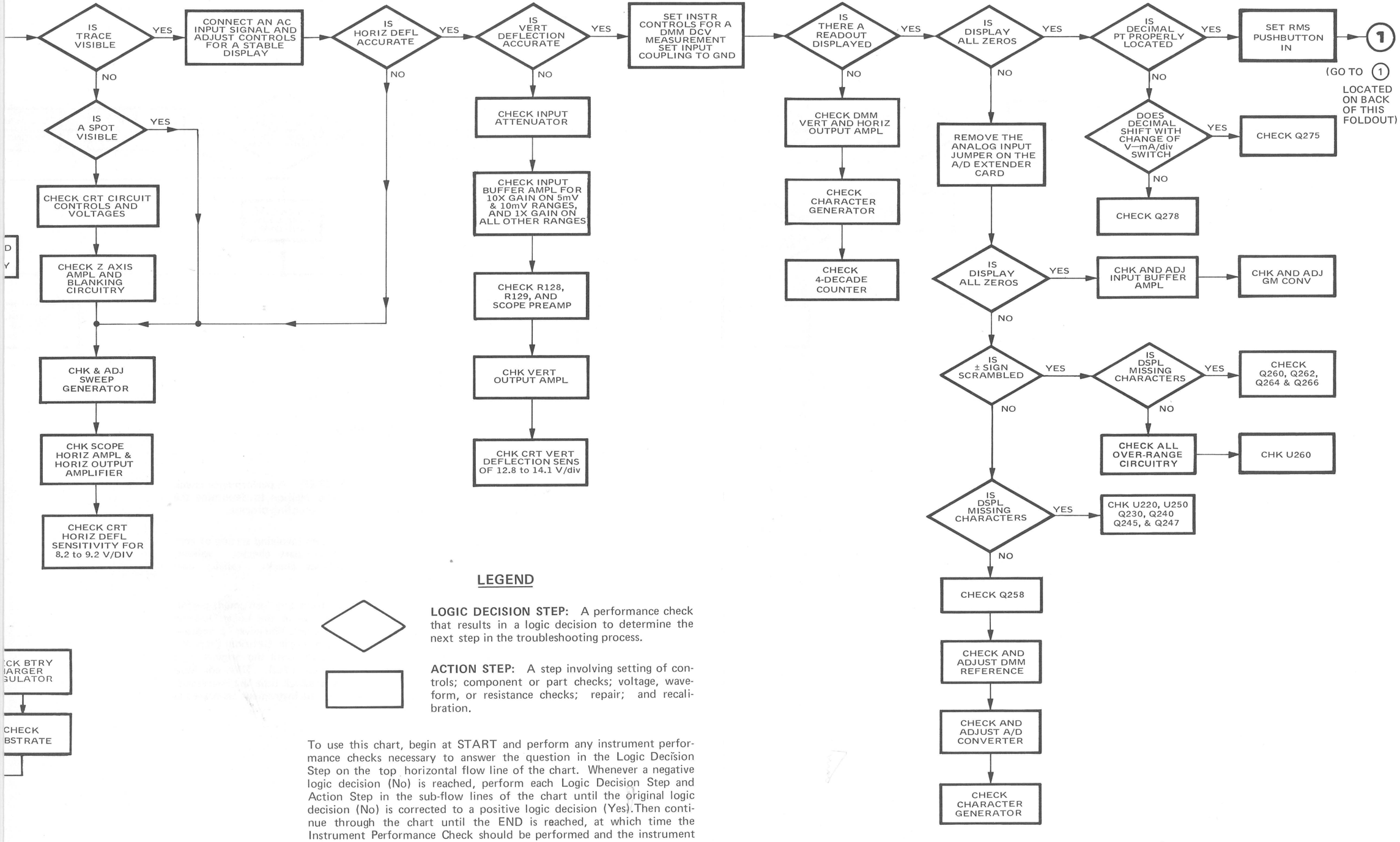

## LEGEND

**LOGIC DECISION STEP:** A performance check that results in a logic decision to determine the next step in the troubleshooting process.

**ACTION STEP:** A step involving setting of controls; component or part checks; voltage, waveform, or resistance checks; repair; and recalibration.

To use this chart, begin at START and perform any instrument performance checks necessary to answer the question in the Logic Decision Step on the top horizontal flow line of the chart. Whenever a negative logic decision (No) is reached, perform each Logic Decision Step and Action Step in the sub-flow lines of the chart until the original logic decision (No) is corrected to a positive logic decision (Yes). Then continue through the chart until the END is reached, at which time the Instrument Performance Check should be performed and the instrument calibrated as required.

**Fig. 9-24. Troubleshooting chart.**




## LEGEND



**LOGIC DECISION STEP:** A performance check that results in a logic decision to determine the next step in the troubleshooting process.

**ACTION STEP:** A step involving setting of controls; component or part checks; voltage, waveform, or resistance checks; repair; and recalibration.

To use this chart, begin at START and perform any instrument performance checks necessary to answer the question in the Logic Decision Step on the top horizontal flow line of the chart. Whenever a negative logic decision (No) is reached, perform each Logic Decision Step and Action Step in the sub-flow lines of the chart until the original logic decision (No) is corrected to a positive logic decision (Yes). Then continue through the chart until the END is reached, at which time the Instrument Performance Check should be performed and the instrument calibrated as required.

**Fig. 9-24. Troubleshooting chart.**

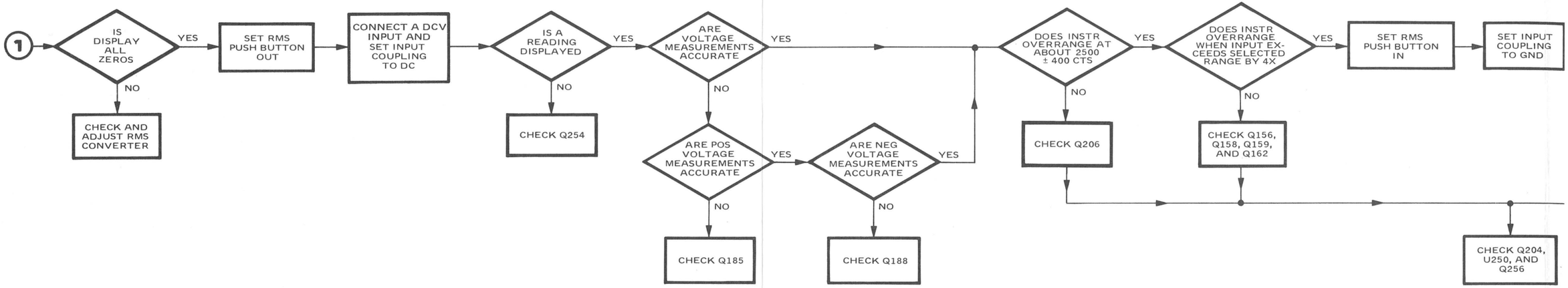
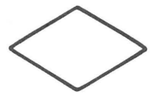



FIG. 9-24 (CONT.)

@

## LEGEND



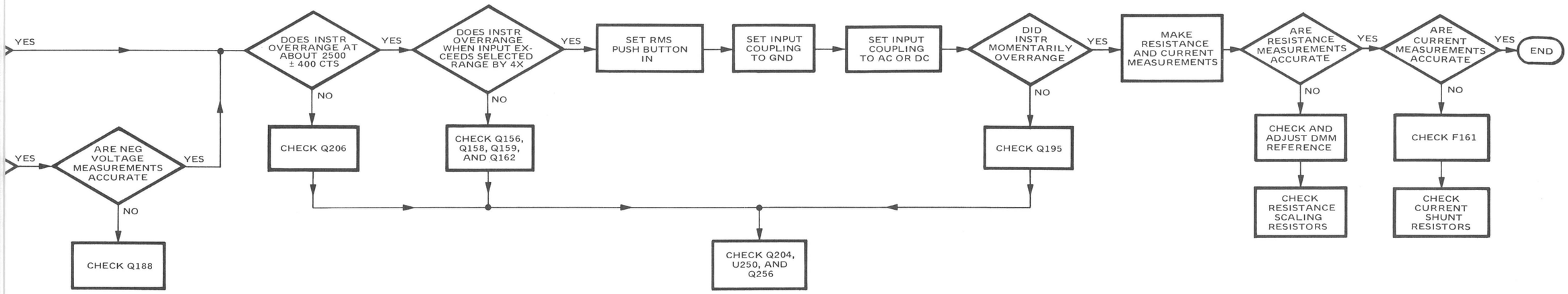
**LOGIC DECISION STEP:** A performance check that results in a logic decision to determine the next step in the troubleshooting process.



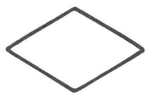
**ACTION STEP:** A step involving setting of controls; component or part checks; voltage, waveform, or resistance checks; repair; and recalibration.

To use this chart, begin at START and perform any instrument performance checks necessary to answer the question in the Logic Decision Step on the top horizontal flow line of the chart. Whenever a negative logic decision (No) is reached, perform each Logic Decision Step and Action Step in the sub-flow lines of the chart until the original logic decision (No) is corrected to a positive decision (Yes). Then continue through the chart until the END is reached, at which time the instrument Performance Check should be performed and the instrument calibrated as required.

**Fig. 9-24 (cont). Troubleshooting chart.**




## LEGEND



**LOGIC DECISION STEP:** A performance check that results in a logic decision to determine the next step in the troubleshooting process.



**ACTION STEP:** A step involving setting of controls; component or part checks; voltage, waveform, or resistance checks; repair; and recalibration.

To use this chart, begin at START and perform any instrument performance checks necessary to answer the question in the Logic Decision Step on the top horizontal flow line of the chart. Whenever a negative logic decision (No) is reached, perform each Logic Decision Step and Action Step in the sub-flow lines of the chart until the original logic decision (No) is corrected to a positive decision (Yes). Then continue through the chart until the END is reached, at which time the instrument Performance Check should be performed and the instrument calibrated as required.

**Fig. 9-24 (cont). Troubleshooting chart.**

# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

| | |
|---|---|
| X000 | Part first added at this serial number |
| 00X | Part removed after this serial number |

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```
1 2 3 4 5                    Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
                - - - * - - -
   Detail Part of Assembly and/or Component
   Attaching parts for Detail Part
                - - - * - - -
      Parts of Detail Part
      Attaching parts for Parts of Detail Part
                - - - * - - -
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

**Attaching parts must be purchased separately, unless otherwise specified.**

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

| | |
|---|---|
| " | INCH |
| # | NUMBER SIZE |
| ACTR | ACTUATOR |
| ADPTR | ADAPTER |
| ALIGN | ALIGNMENT |
| AL | ALUMINUM |
| ASSEM | ASSEMBLED |
| ASSY | ASSEMBLY |
| ATTEN | ATTENUATOR |
| AWG | AMERICAN WIRE GAGE |
| BD | BOARD |
| BRKT | BRACKET |
| BRS | BRASS |
| BRZ | BRONZE |
| BSHG | BUSHING |
| CAB | CABINET |
| CAP | CAPACITOR |
| CER | CERAMIC |
| CHAS | CHASSIS |
| CKT | CIRCUIT |
| COMP | COMPOSITION |
| CONN | CONNECTOR |
| COV | COVER |
| CPLG | COUPLING |
| CRT | CATHODE RAY TUBE |
| DEG | DEGREE |
| DWR | DRAWER |
| ELCTRN | ELECTRON |
| ELEC | ELECTRICAL |
| ELCTLT | ELECTROLYTIC |
| ELEM | ELEMENT |
| EPL | ELECTRICAL PARTS LIST |
| EQPT | EQUIPMENT |
| EXT | EXTERNAL |
| FIL | FILLISTER HEAD |
| FLEX | FLEXIBLE |
| FLH | FLAT HEAD |
| FLTR | FILTER |
| FR | FRAME or FRONT |
| FSTNR | FASTENER |
| FT | FOOT |
| FXD | FIXED |
| GSKT | GASKET |
| HDL | HANDLE |
| HEX | HEXAGON |
| HEX HD | HEXAGONAL HEAD |
| HEX SOC | HEXAGONAL SOCKET |
| HLCPS | HELICAL COMPRESSION |
| HLEXT | HELICAL EXTENSION |
| HV | HIGH VOLTAGE |
| IC | INTEGRATED CIRCUIT |
| ID | INSIDE DIAMETER |
| IDENT | IDENTIFICATION |
| IMPLR | IMPELLER |
| IN | INCH |
| INCAND | INCANDESCENT |
| INSUL | INSULATOR |
| INTL | INTERNAL |
| LPHLDR | LAMPHOLDER |
| MACH | MACHINE |
| MECH | MECHANICAL |
| MTG | MOUNTING |
| NIP | NIPPLE |
| NON WIRE | NOT WIRE WOUND |
| OBD | ORDER BY DESCRIPTION |
| OD | OUTSIDE DIAMETER |
| OVH | OVAL HEAD |
| PH BRZ | PHOSPHOR BRONZE |
| PL | PLAIN or PLATE |
| PLSTC | PLASTIC |
| PN | PART NUMBER |
| PNH | PAN HEAD |
| PWR | POWER |
| RCPT | RECEPTACLE |
| RES | RESISTOR |
| RGD | RIGID |
| RLF | RELIEF |
| RTNR | RETAINER |
| SCH | SOCKET HEAD |
| SCOPE | OSCILLOSCOPE |
| SCR | SCREW |
| SE | SINGLE END |
| SECT | SECTION |
| SEMICOND | SEMICONDUCTOR |
| SHLD | SHIELD |
| SHLDR | SHOULDERED |
| SKT | SOCKET |
| SL | SLIDE |
| SLFLKG | SELF-LOCKING |
| SLVG | SLEEVING |
| SPR | SPRING |
| SQ | SQUARE |
| SST | STAINLESS STEEL |
| STL | STEEL |
| SW | SWITCH |
| T | TUBE |
| TERM | TERMINAL |
| THD | THREAD |
| THK | THICK |
| TNSN | TENSION |
| TPG | TAPPING |
| TRH | TRUSS HEAD |
| V | VOLTAGE |
| VAR | VARIABLE |
| W/ | WITH |
| WSHR | WASHER |
| XFMR | TRANSFORMER |
| XSTR | TRANSISTOR |

# CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

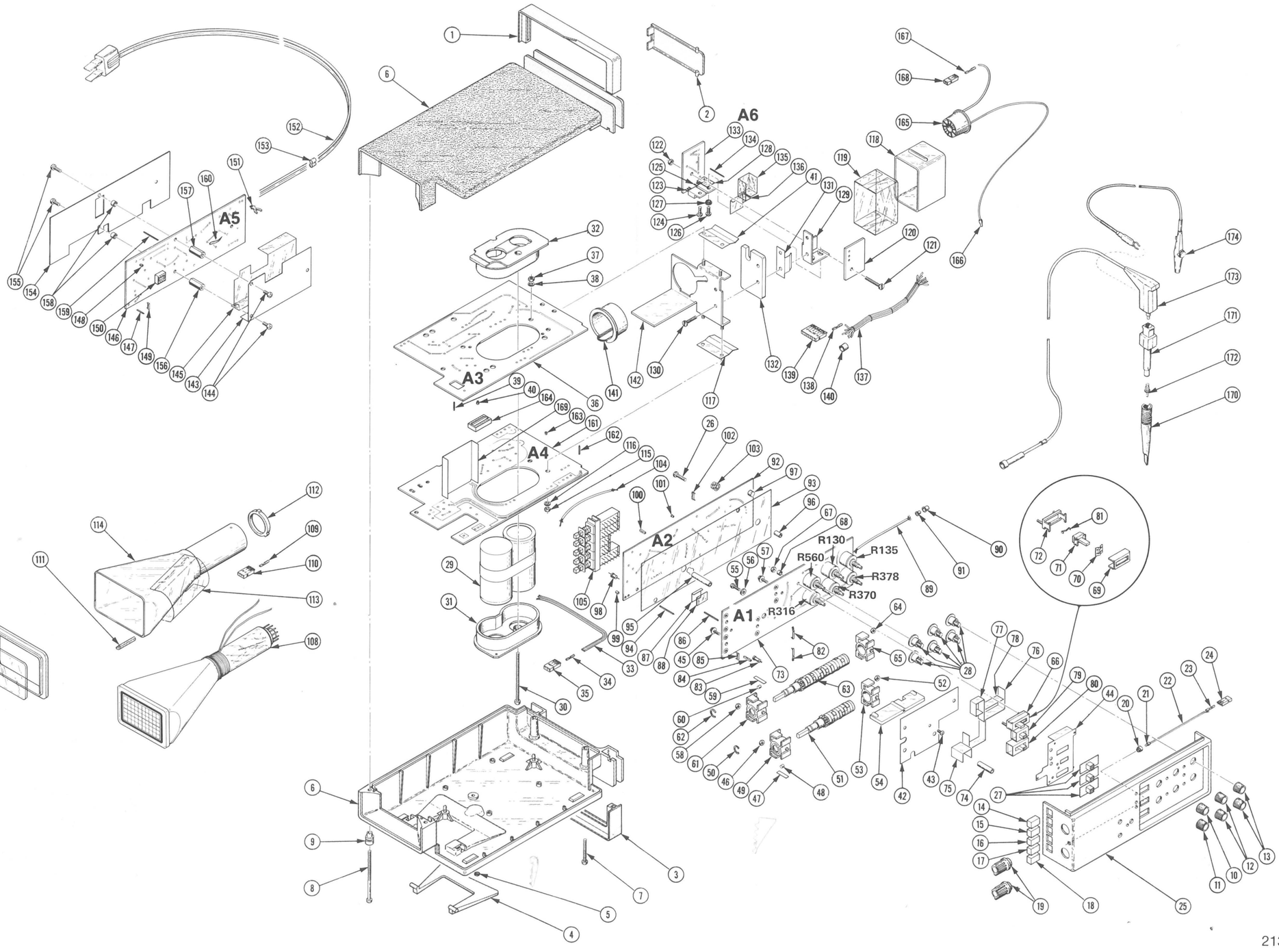
| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|---|---|---|---|
| 00261 | GENERAL ELECTRIC CO<br>FOOD SERVICE EQUIPMENT BUSINESS DEPT | 14TH AND ARNOLD STS | CHICAGO HEIGHTS IL 60411 |
| 00779 | AMP INC | 2800 FULLING MILL<br>PO BOX 3608 | HARRISBURG PA 17105 |
| 07416 | NELSON NAME PLATE CO | 3191 CASITAS | LOS ANGELES CA 90039-2410 |
| 09922 | BURNDY CORP | RICHARDS AVE | NORWALK CT 06852 |
| 12327 | FREEWAY CORP | 9301 ALLEN DR | CLEVELAND OH 44125-4632 |
| 12360 | ALBANY FASTENERS<br>PAWTUCKET FASTERNER DIV | 327 PINE ST<br>PO BOX 879 | PAWTUCKET RI 02862 |
| 14890 | INDUSTRIAL GASKET INC | 8100 SE 15TH ST<br>PO BOX 24048 | OKLAHOMA CITY OK 73124 |
| 18121 | WILSHIRE FOAM PRODUCTS INC | 1240 E 230TH ST | CARSON CA 90745-5010 |
| 18310 | CONCORD ELECTRONICS CORP | 37 GREAT JONES ST | NEW YORK NY 10012-1115 |
| 22526 | DU PONT E I DE NEMOURS AND CO INC<br>DU PONT CONNECTOR SYSTEMS<br>DIV MILITARY PRODUCTS GROUP | 515 FISHING CREEK RD | NEW CUMBERLAND PA 17070-3007 |
| 23740 | AMUNEAL MFG CORP | 4737 DARRAH | PHILADELPHIA PA 19124-2705 |
| 26365 | GRIES DYNACAST CO<br>DIV OF COATS AND CLARK INC | 125 BEECHWOOD AVE | NEW ROCHELLE NY 10802 |
| 33669 | PRECISION TECHNOLOGY INC | 2970 S RICHARDS ST<br>PO BOX 15454 | SALT LAKE UT 84115-3518 |
| 71279 | INTERCONNECTION PRODUCTS INC | 2601 S GARNSEY ST | SANTA ANA CA 92707-3338 |
| 73743 | FISCHER SPECIAL MFG CO | 111 INDUSTRIAL RD | COLD SPRING KY 41076-9749 |
| 75915 | LITTELFUSE INC<br>SUB TRACOR INC | 800 E NORTHWEST HWY | DES PLAINES IL 60016-3049 |
| 79136 | WALDES KOHINOOR INC | 47-16 AUSTEL PLACE | LONG ISLAND CITY NY 11101-4402 |
| 80009 | TEKTRONIX INC | 14150 SW KARL BRAUN DR<br>PO BOX 500 | BEAVERTON OR 97077-0001 |
| 82104 | STANDARD GRIBSBY INC | 920 RATHBONE AVE | AURORA IL 60507 |
| 85471 | BOYD CORP | 13885 RAMOMA AVE | CHINO CA 91710 |
| 86928 | SEASTROM MFG CO INC | 701 SONORA AVE | GLENDALE CA 91201-2431 |
| 87473 | INSULECTRO<br>A DIV OF QUINTEC INDUSTRIES | 3176 AIRWAY AVE | COSTA MESA CA 92626-4608 |
| 91500 | ASHEVILLE-SCHOONMAKER MICA CO | 910 JEFFERSON AVE<br>P O BOX 318 | NEWPORT NEWS VA 23607-6120 |
| 93907 | TEXTRON INC<br>CAMCAR DIV | 600 18TH AVE | ROCKFORD IL 61108-5181 |
| 98159 | RUBBER TECK INC | 19115 HAMILTON AVE<br>PO BOX 389 | GARDENA CA 90247 |
| 98278 | MALCO A MICRODOT CO | 306 PASADENA AVE | SOUTH PASADENA CA 91030-2905 |
| TK0174 | BADGLEY MFG CO | 1620 NE ARGYLE | PORTLAND OR 97211 |
| TK0435 | LEWIS SCREW CO | 4300 S RACINE AVE | CHICAGO IL 60609-3320 |
| TK1319 | MORELLIS Q & D PLASTICS | 1812 16-TH AVE | FOREST GROVE OR 97116 |
| TK2041 | PRECISION COMPONENTS INC | 16285 SW 85TH AVE<br>SUITE 407 | TIGARD OR 97224 |
| TK2165 | TRIQUEST CORP | 3000 LEWIS AND CLARK HWY | VANCOUVER WA 98661-2999 |
| TK2278 | COMTEK MANUFACTURING OF OREGON<br>(METALS) | PO BOX 4200 | BEAVERTON OR 97076-4200 |

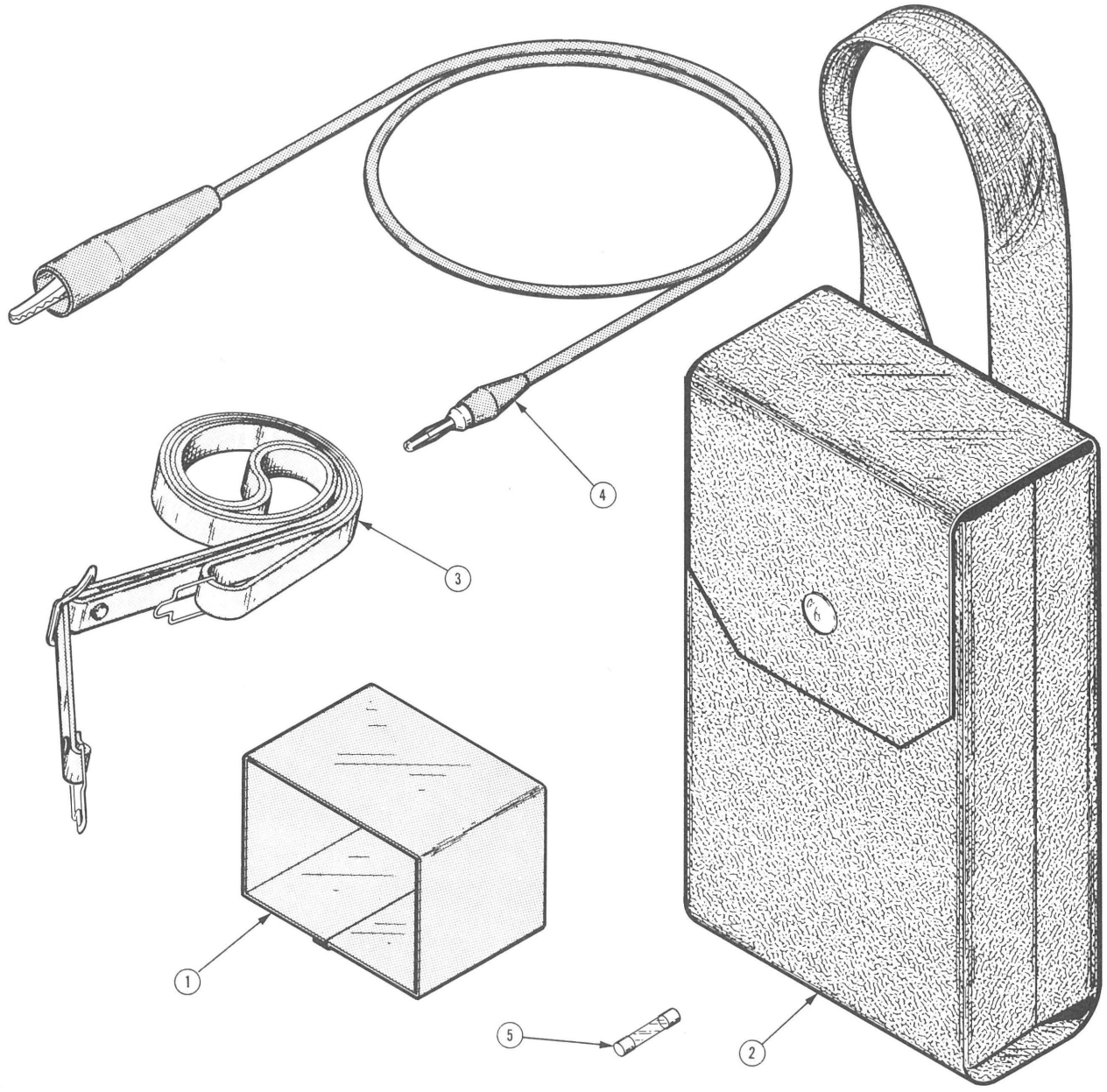
| Fig. & Index No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 1-1 | 200-1468-00 | | | 1 | COVER,CORD WRAP:PROBE,UPPER | 80009 | 200-1468-00 |
| -2 | 200-1400-00 | | | 1 | COVER,ELEC CONN:POWER CORD | TK2165 | ORDER BY DESCR |
| -3 | 200-1467-00 | | | 1 | COVER,CORD WRAP:PROBE,LOWER | 80009 | 200-1467-00 |
| -4 | 348-0285-00 | | | 1 | FLIP-STAND,CAB.:1.95 H,POLYCARBONATE | 80009 | 348-0285-00 |
| -5 | 214-2249-00 | | | 1 | PLUG,HOLE:0.234 OD,PLASTIC | 80009 | 214-2249-00 |
| | 334-2118-00 | | | 1 | MARKER,IDENT:MKD WARNING | 80009 | 334-2118-00 |
| | 334-2118-01 | | | 1 | MARKER,IDENT:MKD WARNING | 80009 | 334-2118-01 |
| -6 | 437-0146-00 | | | 1 | CABINET,SCOPE:TOP & BOTTOM (OPTION 05 ONLY) | 80009 | 437-0146-00 |
| | | | | | ATTACHING PARTS | | |
| -7 | 211-0019-00 | | | 2 | SCREW,MACHINE:4-40 X 1.0,PNH,STL | 93907 | ORDER BY DESCR |
| -8 | 211-0166-00 | | | 2 | SCREW,MACHINE:4-40 X 1.750,PNH,STL | TK0435 | ORDER BY DESCR |
| -9 | 355-0181-00 | | | 2 | STUD,CRYG HDL: | TK2278 | ORDER BY DESCR |
| | | | | | END ATTACHING PARTS | | |
| | | | | | CABINET ASSY INCLUDES: | | |
| | 348-0254-01 | | | 4 | .FOOT,CABINET:BLACK RUBBER | 80009 | 348-0254-01 |
| -10 | 366-1596-04 | | | 1 | KNOB:GY,INT,0.173 ID X 0.44 OD X 0.394 H | 80009 | 366-1596-04 |
| -11 | 366-1596-03 | | | 1 | KNOB:GY,TRIG,0.173 ID X 0.44 OD X 0.394 H | 80009 | 366-1596-03 |
| -12 | 366-1596-02 | | | 2 | KNOB:GY,VAR,0.173 ID X 0.44 OD X 0.394 H | 80009 | 366-1596-02 |
| -13 | 366-1596-01 | | | 2 | KNOB:GY,POS,0.173 ID X 0.44 OD X 0.394 H | 80009 | 366-1596-01 |
| -14 | 366-1402-84 | | | 1 | PUSH BUTTON:SIL GY,DVM | 80009 | 366-1402-84 |
| -15 | 366-1402-85 | | | 1 | PUSH BUTTON:SIL,GY,RMS | 80009 | 366-1402-85 |
| -16 | 366-1402-86 | | | 1 | PUSH BUTTON:SIL GY,VOLTS | 80009 | 366-1402-86 |
| -17 | 366-1402-87 | | | 1 | PUSH BUTTON:SIL GY,MA | 80009 | 366-1402-87 |
| -18 | 366-1402-88 | | | 1 | PUSH BUTTON:SIL GY,OHM SYMBOL | 80009 | 366-1402-88 |
| -19 | 366-1488-01 | | | 2 | KNOB:GY,0.128 ID X 0.5 OD X 0.688 H | 80009 | 366-1488-01 |
| -20 | 352-0360-00 | B010100 | B032027 | 1 | HOLDER,LED:BLACK RUBBER | 80009 | 352-0360-00 |
| | 352-0360-01 | B032028 | | 1 | HOLDER,LED:BLACK RUBBER | TK1319 | N/A |
| -21 | ----- ----- | | | 1 | .LAMP,LED:RED(SEE CR450 REPL) | | |
| -22 | 175-0825-00 | | | AR | .CABLE,SP,ELEC:2,26 AWG,STRD,PVC JKT,RBN | 80009 | 175-0825-00 |
| -23 | 131-0707-00 | | | 2 | .CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL | 22526 | 47439-000 |
| -24 | 352-0169-00 | | | 1 | .HLDR,TERM CONN:2 WIRE,BLACK | 80009 | 352-0169-00 |
| -25 | 333-1718-00 | | | 1 | PANEL,SIDE: | TK2165 | ORDER BY DESCR |
| | | | | | ATTACHING PARTS | | |
| -26 | 211-0014-00 | | | 2 | SCREW,MACHINE:4-40 X 0.5,PNH,STL | 93907 | ORDER BY DESCR |
| | | | | | END ATTACHING PARTS | | |
| -27 | 200-1512-00 | | | 3 | COVER,SLIDE SW: | TK1319 | N/A |
| -28 | 342-0263-00 | | | 6 | INSUL,VAR RES:NYLON,BLACK | TK1319 | N/A |
| | 214-2228-00 | | | 1 | .PIN,KNOB INDEX:0.026 OD X 0.19,SST | 80009 | 214-2228-00 |
| | ----- ----- | | | AR | .BATTERY ASSY:(SEE BT444 REPL) | | |
| -29 | 146-0028-00 | | | 1 | BATTERY,STORAGE:2.4V,4AH @ 350MA,(2)D CELL, NICAD | 80009 | 146-0028-00 |
| | | | | | ATTACHING PARTS | | |
| -30 | 211-0170-00 | | | 1 | SCREW,MACHINE:4-40 X 2.25,PNH,SST | 93907 | ORDER BY DESCR |
| -31 | 343-0402-00 | | | 1 | RETAINER,BAT:PLASTIC | 80009 | 343-0402-00 |
| -32 | 343-0402-01 | | | 1 | RETAINER,BAT:W/INSERT,PLASTIC | 80009 | 343-0402-01 |
| | | | | | END ATTACHING PARTS | | |
| | 198-2200-00 | | | 1 | WIRE SET,ELEC: | 80009 | 198-2200-00 |
| -33 | 175-0862-00 | | | AR | .CABLE,SP,ELEC:3,22 AWG,STRD,PVC JKT,RBN | TK0846 | 03CF22M19-BBT |
| -34 | 131-0707-00 | | | 3 | .CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL | 22526 | 47439-000 |
| -35 | 352-0161-00 | | | 1 | .HLDR,TERM CONN:3 WIRE,BLACK | 80009 | 352-0161-00 |
| -36 | ----- ----- | | | 1 | CKT BOARD ASSY:A/D CONVERTER(SEE A3 REPL) | | |
| | | | | | ATTACHING PARTS | | |
| -37 | 210-0406-00 | | | 2 | NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL | 73743 | 12161-50 |
| -38 | 210-0994-00 | | | 2 | WASHER,FLAT:0.125 ID X 0.25 OD X 0.022,STL | 86928 | A371-283-20 |
| | | | | | END ATTACHING PARTS | | |
| | | | | | .CKT BOARD ASSY INCLUDES: | | |
| -39 | 131-0589-00 | | | 19 | .TERM,PIN:0.46 L X 0.025 SQ PH BRZ GLD PL | 22526 | 48283-029 |
| -40 | 136-0252-07 | B010100 | B046248 | 108 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| | 136-0252-07 | B046249 | | 6 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| -41 | 131-1367-00 | | | 1 | CONTACT,ELEC:LINE CONV GND,CU BE TIN PL | 80009 | 131-1367-00 |
| | 672-0452-00 | | | 1 | CIRCUIT BD ASSY:ATTEN,TIME/CM W/SWITCH | 80009 | 672-0452-00 |
| -42 | 337-1786-00 | | | 1 | .SHIELD,ELEC:CAM SWITCH | TK2278 | ORDER BY DESCR |
| | | | | | ATTACHING PARTS | | |
| -43 | 211-0108-00 | | | 1 | .SCREW,MACHINE:2-56 X 0.156,PNH,STL,CD PL, .POZ | TK0435 | ORDER BY DESCR |
| | | | | | END ATTACHING PARTS | | |
| -44 | 337-1851-00 | | | 1 | .SHIELD,ELEC:SLIDE SWITCH | 80009 | 337-1851-00 |

| Fig. & Index No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 1- | 263-1089-00 | | | 1 | .SW CAM ACTR AS:SEC/DIV | 80009 | 263-1089-00 |
| | | | | | ATTACHING PARTS | | |
| -45 | 211-0182-00 | | | 4 | .SCR,ASSEM WSHR:2-56 X 0.312,PNH,BRS,NP,POZ | 12360 | ORDER BY DESCR |
| | | | | | END ATTACHING PARTS | | |
| | | | | | .ACTUATOR ASSY INCLUDES: | | |
| -46 | 210-0405-00 | | | 2 | ..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL | 73743 | 12157-50 |
| -47 | 214-1704-00 | B010100 | B044709 | 2 | ..SPRING,FLAT:0.52 X 0.125 X 0.006,CU BE | 80009 | 214-1704-00 |
| | 214-1704-00 | B044710 | | 1 | ..SPRING,FLAT:0.52 X 0.125 X 0.006,CU BE | 80009 | 214-1704-00 |
| | 214-1704-01 | B044710 | | 1 | ..SPRING,FLAT:0.52 X 0.125 X 0.008,CU BE | 80009 | 214-1704-01 |
| -48 | 214-1127-00 | | | 2 | ..ROLLER,DETENT:0.125 DIA X 0.125,SST | 80009 | 214-1127-00 |
| -49 | 401-0155-00 | | | 1 | ..BEARING,CAM SW:FRONT,0.454 DIA CAM | 80009 | 401-0155-00 |
| | | | | | ATTACHING PARTS | | |
| -50 | 354-0219-00 | | | 1 | ..RING,RETAINING:EXT,CRESCENT,U/O 0.25 DIA | 79136 | 5103-25-S-ZD-R |
| | | | | | END ATTACHING PARTS | | |
| -51 | 105-0453-00 | | | 1 | ..ACTUATOR,CAM SW:TIME/DIV | 80009 | 105-0453-00 |
| -52 | 210-0405-00 | | | 2 | ..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL | 73743 | 12157-50 |
| -53 | 401-0156-00 | | | 1 | ..BEARING,CAM SW:REAR,0.454 DIA CAM | 80009 | 401-0156-00 |
| -54 | 337-1806-01 | | | 1 | .SHIELD,ELEC:INPUT CKT BD | TK2278 | ORDER BY DESCR |
| | | | | | ATTACHING PARTS | | |
| -55 | 213-0277-00 | | | 3 | .SCREW,TPG,TF:2-56 X 0.312,SPCL TYPE,PNH,STL | 93907 | 234-01725-024 |
| -56 | 210-1008-00 | | | 3 | .WASHER,FLAT:0.09 ID X 0.188 OD X 0.02,BRS | 12327 | ORDER BY DESCR |
| | | | | | END ATTACHING PARTS | | |
| | 263-1088-00 | | | 1 | .SW CAM ACTR AS:VOLTS-MA/DIV | 80009 | 263-1088-00 |
| | | | | | ATTACHING PARTS | | |
| -57 | 211-0182-00 | | | 4 | .SCR,ASSEM WSHR:2-56 X 0.312,PNH,BRS,NP,POZ | 12360 | ORDER BY DESCR |
| | | | | | END ATTACHING PARTS | | |
| | | | | | .ACTUATOR ASSY INCLUDES: | | |
| -58 | 210-0405-00 | | | 2 | ..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL | 73743 | 12157-50 |
| -59 | 214-1704-00 | | | 1 | ..SPRING,FLAT:0.52 X 0.125 X 0.006,CU BE | 80009 | 214-1704-00 |
| | 214-1704-01 | | | 1 | ..SPRING,FLAT:0.52 X 0.125 X 0.008,CU BE | 80009 | 214-1704-01 |
| -60 | 214-1127-00 | | | 2 | ..ROLLER,DETENT:0.125 DIA X 0.125,SST | 80009 | 214-1127-00 |
| -61 | 401-0155-00 | | | 1 | ..BEARING,CAM SW:FRONT,0.454 DIA CAM | 80009 | 401-0155-00 |
| | | | | | ATTACHING PARTS | | |
| -62 | 354-0219-00 | | | 1 | ..RING,RETAINING:EXT,CRESCENT,U/O 0.25 DIA | 79136 | 5103-25-S-ZD-R |
| | | | | | END ATTACHING PARTS | | |
| -63 | 105-0451-00 | | | 1 | ..ACTUATOR,CAM SW:ATTENUATOR | 80009 | 105-0451-00 |
| -64 | 210-0405-00 | | | 2 | ..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL | 73743 | 12157-50 |
| -65 | 401-0156-00 | | | 1 | ..BEARING,CAM SW:REAR,0.454 DIA CAM | 80009 | 401-0156-00 |
| -66 | 105-0661-00 | | | 1 | .ACTUATOR,SWITCH:SLIDE,W/O CONTACTS | 80009 | 105-0661-00 |
| | | | | | ATTACHING PARTS | | |
| -67 | 220-0627-00 | | | 2 | .NUT,PLAIN,HEX:2-56 X 0.156 HEX,BRS NP | 73743 | 10002-56-101 |
| -68 | 361-0719-00 | | | 2 | .SPACER,SLEEVE:0.062 L X 0.092 ID,PHENOLIC | 82104 | 10-0144/0622 |
| | | | | | END ATTACHING PARTS | | |
| | | | | | .ACTUATOR ASSY INCLUDES: | | |
| -69 | 380-0426-00 | | | 1 | ..HOUSING,ACTR:SLIDE SW | 80009 | 380-0426-00 |
| -70 | 214-2206-00 | | | 1 | ..SPRING,DETENT:SLIDE SWITCH | 80009 | 214-2206-00 |
| -71 | 105-0649-00 | | | 1 | ..ACTUATOR,SL SW:PROGRAMMABLE | 80009 | 105-0649-00 |
| -72 | 426-1194-00 | | | 1 | ..FRAME,SLIDE SW: | 80009 | 426-1194-00 |
| -73 | ----- ----- | | | 1 | .CKT BOARD ASSY:ATTENUATOR(SEE A1 REPL) | | |
| -74 | 129-0397-01 | | | 2 | ..POST,CONTACT:.940 OA LG;CD PL BR | TK2278 | ORDER BY DESCR |
| -75 | 337-2075-00 | | | 1 | ..SHIELD,ELEC:EXT TRIGGER,FRONT | 80009 | 337-2075-00 |
| -76 | 337-1787-00 | | | 1 | ..SHIELD,ELEC:SLIDE SWITCH | 80009 | 337-1787-00 |
| -77 | 337-1861-00 | | | 1 | ..SHIELD,ELEC:ATTENUATOR | 80009 | 337-1861-00 |
| -78 | 337-2139-00 | | | 1 | ..SHIELD,ELEC:INPUT CPLG SW | 80009 | 337-2139-00 |
| -79 | ----- ----- | | | 1 | ..SWITCH,SLIDE:POWER (SEE S480 REPL) | | |
| -80 | ----- ----- | | | 1 | ..SWITCH,SLIDE:TRIGGER(SEE S315 REPL) | | |
| -81 | 131-1570-01 | | | 2 | ..CONTACT,ELEC:MBS | 80009 | 131-1570-01 |
| -82 | 131-0604-00 | | | 31 | ..CONTACT,ELEC:CKT BD SW,SPR,CU BE | 80009 | 131-0604-00 |
| -83 | 136-0387-00 | | | 1 | ..JACK,TIP:U/W 0.04 DIA PIN,GRAY | 71279 | 4504352010318 |
| -84 | 136-0263-04 | | | 9 | ..SOCKET,PIN TERM:U/W 0.025 SQ PIN | 22526 | 75377-001 |
| -85 | 136-0328-03 | B010100 | B045239 | 28 | ..SOCKET,PIN TERM:U/W 0.025 SQ PINS | 22526 | 47710 |
| | 136-0328-02 | B045240 | | 28 | ..SOCKET,PIN TERM:U/W 0.025 SQ PINS | 00779 | 102081-1 |
| -86 | 131-0590-00 | | | 3 | ..TERMINAL,PIN:0.71 L X 0.025 SQ PH BRZ | 22526 | 47331 |
| -87 | 337-2076-00 | | | 1 | ..SHIELD,ELEC:EXT TRIGGER,REAR | 80009 | 337-2076-00 |
| -88 | 342-0266-00 | | | 1 | ..INSULATOR,SHLD:EXT TRIG,REAR,POLYIMIDE | 14890 | ORDER BY DESCR |
| -89 | 175-1255-00 | | | AR | ..CABLE,RF:50 OHM COAX,WHITE VINYL JKT | 80009 | 175-1255-00 |
| -90 | 210-0774-00 | | | 1 | ..EYELET,METALLIC:0.152 OD X 0.218 L,BRS | 80009 | 210-0774-00 |
| -91 | 210-0775-00 | | | 1 | ..EYELET,METALLIC:0.126 OD X 0.205 L,BRS | 80009 | 210-0775-00 |

| Fig. & Index No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 1- | 334-3448-00 | B043350 | | 1 | ..MARKER,IDENT:MARKED NOTICE | 07416 | ORDER BY DESCR |
| | 198-2847-00 | B010100 | B044939 | 1 | .WIRE SET,ELEC: | 80009 | 198-2847-00 |
| | 198-2847-01 | B044940 | | 1 | .WIRE SET,ELEC: | 80009 | 198-2847-01 |
| -92 | ----- ----- | | | 1 | CKT BOARD ASSY:FUNCTION(SEE A2 REPL) | | |
| -93 | 342-0198-00 | | | 1 | .INSULATOR,FILM:CIRCUIT BOARD,MYLAR | 85471 | ORDER BY DESCR |
| -94 | 131-0590-00 | | | 9 | .TERMINAL,PIN:0.71 L X 0.025 SQ PH BRZ | 22526 | 47331 |
| -95 | 129-0397-01 | | | 1 | .POST,CONTACT:.940 OA LG;CD PL BR | TK2278 | ORDER BY DESCR |
| -96 | 361-0565-00 | | | 2 | .SPACER,SLEEVE:0.218 L X 0.132 ID,BRS | TK2278 | ORDER BY DESCR |
| -97 | 253-0154-00 | | | 4 | .TAPE,PRESS SENS:FOAM,0.25 X 0.125,0.25 DIA .DOTS,ADH BOTH SIDES | 18121 | MT8 |
| -98 | 131-0158-00 | | | 1 | .TERM,FEEDTHRU:0.571 L X 0.04 OD,BRS,SIL PL | 18310 | 1110-29-0519 |
| -99 | 136-0261-00 | | | 2 | .SOCKET,PIN TERM:U/W 0.022 TO 0.025 PIN | 00779 | 1-331677-6 |
| -100 | 136-0263-04 | | | 3 | .SOCKET,PIN TERM:U/W 0.025 SQ PIN | 22526 | 75377-001 |
| -101 | 136-0252-07 | B010100 | B046248 | 148 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| | 136-0252-07 | B046249 | | 88 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| -102 | 136-0328-03 | B010100 | B045239 | 18 | .SOCKET,PIN TERM:U/W 0.025 SQ PINS | 22526 | 47710 |
| | 136-0328-02 | B045240 | | 18 | .SOCKET,PIN TERM:U/W 0.025 SQ PINS | 00779 | 102081-1 |
| -103 | 200-0385-00 | | | 2 | .COVER,XSTR:TO-5,THERMO FIT KYNAR | 87473 | 1009016 |
| -104 | 175-1087-00 | | | AR | .CABLE,RF:75 OHM COAX,WHITE VINYL JKT | 80009 | 175-1087-00 |
| -105 | ----- ----- | | | 1 | .SW,PUSHBUTTON:(SEE S155, S165 AND S185 REP | | |
| -106 | 378-0691-00 | | | 1 | FILTER,LT,CRT:BLUE,2.53 X 1.73 X 0.03 | 80009 | 378-0691-00 |
| | 331-0445-00 | B042623 | | 1 | MASK,CRT SCALE: | 80009 | 331-0445-00 |
| -107 | 386-1999-00 | | | 1 | SUPPORT,CRT:FRONT | 80009 | 386-1999-00 |
| -108 | ----- ----- | | | 1 | CRT ASSEMBLY:W/COIL(SEE V560 REPL) | | |
| -109 | 131-0707-00 | | | 3 | .CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL | 22526 | 47439-000 |
| -110 | 352-0161-00 | | | 1 | .HLDR,TERM CONN:3 WIRE,BLACK | 80009 | 352-0161-00 |
| -111 | 253-0153-00 | | | 4 | TAPE,PRESS SENS:FOAM,0.25 X 0.125 | 18121 | ORDER BY DESCR |
| -112 | 354-0423-00 | | | 1 | RING,CRT SPRT:BLACK VINYL | TK1319 | N/A |
| -113 | 342-0272-00 | | | 1 | INSUL,CRT SHLD:POLYESTER | 80009 | 342-0272-00 |
| -114 | 337-1458-00 | | | 1 | SHIELD,CRT: | 23740 | 337-1458-00-D |
| | 672-0414-00 | | | 1 | CIRCUIT BD ASSY:LINE CONN<br>ATTACHING PARTS | 80009 | 672-0414-00 |
| -115 | 210-0406-00 | | | 2 | NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL | 73743 | 12161-50 |
| -116 | 210-0994-00 | | | 2 | WASHER,FLAT:0.125 ID X 0.25 OD X 0.022,STL | 86928 | A371-283-20 |
| -117 | 131-1367-00 | | | 1 | CONTACT,ELEC:LINE CONV GND,CU BE TIN PL<br>END ATTACHING PARTS | 80009 | 131-1367-00 |
| -118 | 200-1529-00 | | | 1 | .COVER,BAT CHGR: | TK2165 | ORDER BY DESCR |
| -119 | 342-0188-00 | | | 1 | .INSULATOR,FILM:LINE CONVERTER,MYLAR | 85471 | ORDER BY DESCR |
| -120 | 119-0704-00 | | | 1 | .RECTIFIER NTWK:<br>ATTACHING PARTS | 80009 | 119-0704-00 |
| -121 | 211-0191-00 | | | 1 | .SCREW,MACHINE:4-40 X 0.750,BDGH,NYL | 80009 | 211-0191-00 |
| -122 | 210-0406-00 | | | 1 | .NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL<br>END ATTACHING PARTS | 73743 | 12161-50 |
| -123 | ----- ----- | | | 1 | .TRANSISTOR:CHAS MTG(SEE Q422 REPL)<br>ATTACHING PARTS | | |
| -124 | 211-0008-00 | | | 1 | .SCREW,MACHINE:4-40 X 0.25,PNH,STL<br>END ATTACHING PARTS | 93907 | ORDER BY DESCR |
| -125 | ----- ----- | | | 1 | .TRANSISTOR:CHAS MTG(SEE Q424 REPL)<br>ATTACHING PARTS | | |
| -126 | 211-0008-00 | | | 1 | .SCREW,MACHINE:4-40 X 0.25,PNH,STL | 93907 | ORDER BY DESCR |
| -127 | 210-1171-00 | | | 1 | .WASHER,SHLDR:0.12 ID X 0.143 OD X 0.07 D<br>END ATTACHING PARTS | 00261 | A7148516P2 |
| -128 | 342-0202-00 | | | 1 | .INSULATOR,PLATE:TRANSISTOR,MICA | 91500 | 10-21-023-106 |
| -129 | 407-1307-00 | | | 1 | .BRACKET,CKT BD:ALUMINUM<br>ATTACHING PARTS | TK2278 | ORDER BY DESCR |
| -130 | 211-0036-00 | | | 2 | .SCREW,MACHINE:4-40 X 0.5,BDGH,NYL<br>END ATTACHING PARTS | 26365 | ORDER BY DESCR |
| -131 | 131-1368-00 | | | 1 | .CONTACT,ELEC:LINE CONV INV,CU BE TIN PL | 80009 | 131-1368-00 |
| -132 | 204-0602-01 | | | 1 | .SBSTR,PRINTED:BATTERY CHARGER COVER | 80009 | 204-0602-01 |
| -133 | ----- ----- | | | 1 | .CKT BOARD ASSY:SEC PWR SUPPLY(SEE A6 REPL) | | |
| -134 | 131-0590-00 | | | 3 | ..TERMINAL,PIN:0.71 L X 0.025 SQ PH BRZ | 22526 | 47331 |
| -135 | 342-0267-00 | | | 1 | ..INSULATOR,XFMR:BATTERY CHARGER,POLYIMIDE | TK2278 | ORDER BY DESCR |
| -136 | 342-0268-00 | | | 1 | ..INSULATOR,XFMR:BASE DRIVE,POLYIMIDE | TK2278 | ORDER BY DESCR |
| -137 | 179-1984-00 | | | 1 | ..WIRING HARNESS:POWER SUPPLY | 80009 | 179-1984-00 |
| -138 | 131-0707-00 | | | 5 | ...CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL | 22526 | 47439-000 |
| -139 | 352-0165-06 | | | 1 | ...HLDR,TERM CONN:7 WIRE,BLUE | 80009 | 352-0165-06 |
| -140 | 348-0055-00 | | | 1 | ..GROMMET,PLASTIC:GRAY,ROUND,0.207 ID | 80009 | 348-0055-00 |
| -141 | 354-0467-00 | | | 1 | .RING,RETAINER:CRT SHLD,BLK POLYPROPYLENE | 80009 | 354-0467-00 |

| Fig. & Index No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 1-142 | 441-1156-00 | | | 1 | .CHASSIS,SCOPE:LINE CONVERTER | TK2278 | ORDER BY DESCR |
| -143 | 337-1797-00 | | | 1 | SHIELD,ELEC:PWR SPLY COPNT SIDE<br>ATTACHING PARTS | TK2278 | ORDER BY DESCR |
| -144 | 211-0008-00 | | | 3 | SCREW,MACHINE:4-40 X 0.25,PNH,STL<br>END ATTACHING PARTS | 93907 | ORDER BY DESCR |
| -145 | 342-0259-00 | | | 1 | INSULATOR,PLATE:POWER SUPPLY,POLYESTER | 85471 | ORDER BY DESCR |
| -146 | ----- ----- | | | 1 | CKT BOARD ASSY:POWER SUPPLY(SEE A5 REPL) | | |
| -147 | 131-0608-00 | | | 10 | .TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL | 22526 | 48283-036 |
| -148 | 136-0252-07 | B010100 | B046248 | 48 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| | 136-0252-07 | B046249 | | 15 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| -149 | 136-0328-03 | B010100 | B045239 | 17 | .SOCKET,PIN TERM:U/W 0.025 SQ PINS | 22526 | 47710 |
| | 136-0328-02 | B045240 | | 17 | .SOCKET,PIN TERM:U/W 0.025 SQ PINS | 00779 | 102081-1 |
| -150 | 136-0514-00 | B010100 | B046248 | 1 | .SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP | 09922 | DILB8P-108 |
| -151 | 344-0255-00 | | | 2 | .CLIP,ELECTRICAL:FUSE,CKT BD MT,CU BE | 80009 | 344-0255-00 |
| -152 | 161-0078-01 | | | 1 | .CABLE ASSY,PWR,:2,18AWG,125V,50.0 L<br>.W/FERRULE | 80009 | 161-0078-01 |
| -153 | ----- ----- | | | 1 | .(NOT REPLACEABLE) | | |
| -154 | 388-4062-00 | | | 1 | .CIRCUIT BOARD:SHIELD,POWER SUPPLY,REAR<br>ATTACHING PARTS | 80009 | 388-4062-00 |
| -155 | 211-0097-00 | | | 3 | .SCREW,MACHINE:4-40 X 0.312,PNH,STL | 93907 | ORDER BY DESCR |
| -156 | 129-0420-00 | | | 1 | .SPACER,POST:0.575 L,4-40,AL,0.188 OD | 80009 | 129-0420-00 |
| -157 | 129-0421-00 | | | 2 | .SPACER,POST:0.575 L,4-40,NYLON,0.188 HEX<br>END ATTACHING PARTS | 33669 | ORDER BY DESCR |
| -158 | 361-0548-00 | | | 3 | .SPACER,SLEEVE:0.11 L X 0.125 ID,DELRIN | TK2041 | ORDER BY DESCR |
| -159 | 131-0589-00 | | | 3 | .TERM,PIN:0.46 L X 0.025 SQ PH BRZ GLD PL | 22526 | 48283-029 |
| -160 | 346-0032-00 | | | 1 | .STRAP,RETAINING:0.075 DIA X 4.0 L,MLD RBR | 98159 | 2829-75-4 |
| -161 | ----- ----- | | | 1 | CKT BOARD ASSY:OUTPUT AMP(SEE A4 REPL) | | |
| -162 | 131-0589-00 | | | 48 | .TERM,PIN:0.46 L X 0.025 SQ PH BRZ GLD PL | 22526 | 48283-029 |
| -163 | 136-0252-07 | B010100 | B031383 | 73 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| | 136-0252-07 | B031384 | B046248 | 70 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| | 136-0252-07 | B046249 | | 28 | .SOCKET,PIN CONN:W/O DIMPLE | 22526 | 75060-012 |
| -164 | 136-0260-02 | B010100 | B046248 | 1 | .SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP | 09922 | DILB16P-108T |
| -165 | 136-0552-00 | | | 1 | .SKT,PL-IN ELEK:ELCTRN TUBE,11 CONT W/LEADS | 80009 | 136-0552-00 |
| -166 | 131-0371-00 | B010100 | B032019 | 9 | ..CONNECTOR,TERM:U/W 26 AWG WIRE | 98278 | 122-0182-019 |
| -167 | 131-0707-00 | B010100 | B032019 | 2 | ..CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL | 22526 | 47439-000 |
| | 131-0707-00 | B032120 | | 11 | ..CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL | 22526 | 47439-000 |
| -168 | 352-0169-00 | | | 1 | ..HLDR,TERM CONN:2 WIRE,BLACK | 80009 | 352-0169-00 |
| -169 | 337-1790-00 | | | 1 | .SHIELD,ELEC:FUNCT SWITCH | 80009 | 337-1790-00 |
| | 010-0262-03 | | | 1 | PROBE,VOLTAGE:211,48.0 L,10M OHM/10M OHM | 80009 | 010-0262-03 |
| -170 | 013-0107-02 | | | 1 | .TIP,PROBE:RETRACTABLE HOOK | 80009 | 013-0107-02 |
| -171 | 204-0594-03 | | | 1 | .BODY,PROBE: | 80009 | 204-0594-03 |
| -172 | 206-0191-01 | | | 1 | ..TIP,PROBE:SET OF 10 | 80009 | 206-0191-01 |
| -173 | 175-1498-01 | | | 1 | .CABLE ASSY,RF:94 OHM COAX,49.125 L | 80009 | 175-1498-01 |
| -174 | 175-0940-01 | | 8535 | 1 | .LEAD,ELECTRICAL:STRD,23 AWG,15.0 L | 80009 | 175-0940-01 |
| | 175-0940-03 | 8536 | | 1 | .LEAD,ELECTRICAL:STRD,23 AWG,15.0 L | 80009 | 175-0940-03 |


A5
A6
A3
A4
A2
A1
R130
R560
R135
R378
R370
R316




| Fig. & Index No. | Tektronix Part No. | Serial/Assembly No. Effective | Dscont | Qty | 12345 | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|---|
| 2- | | | | | | STANDARD ACCESSORIES | | |
| -1 | 016-0199-01 | | | 1 | | VISOR,CRT: | 80009 | 016-0199-01 |
| -2 | 016-0512-00 | | | 1 | | CASE,CARRYING: | TK0174 | 016-0512-00 |
| -3 | 346-0104-00 | | | 1 | | STRAP,CARRYING: | 80009 | 346-0104-00 |
| -4 | 012-0014-00 | | | 1 | | LEAD,ELECTRICAL:32.0 L,BLK,BANANA PL ONE | 80009 | 012-0014-00 |
| | 012-0015-00 | | | 1 | | LEAD,ELECTRICAL:32.0 L,RED,BANANA PL ONE | 80009 | 012-0015-00 |
| -5 | 159-0074-00 | | | 2 | | FUSE,CARTRIDGE:5 X 20MM,0.1A,250V,0.04 SEC | 75915 | 218.100 |
| | 070-1480-00 | | | 1 | | MANUAL,TECH:OPERATORS | 80009 | 070-1480-00 |
| | 070-1481-00 | | | 1 | | MANUAL,TECH:INSTRUCTION | 80009 | 070-1481-00 |
| | 161-0077-01 | | | 1 | | CABLE ASSY,PWR,:2,18AWG,125V,10.0 L (OPTION 1 ONLY) | 80009 | 161-0077-01 |
| | 334-2614-00 | | | 1 | | MARKER,IDENT:MKD PROPERTY OF | 80009 | 334-2614-00 |
| | 000-7983-00 | | | 1 | | MARKER,IDENT:INSTRUMENT ID | 80009 | 000-7983-00 |